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VOLVO COUPES/SEDANS/WAGONS 1970-89 REPAIR MANUAL

CHILTON

Covers all U.S. and Canadian models of Volvo 1800, 142, 144, 145, 164, 242, 244, 245, 262, 264, 265, 740, 760, 780, DL, GL, GT, GLE, GLT and Coupe; including diesel & turbo models

The First Step In Repair

INCLUDES WIRING AND VACUUM DIAGRAMS

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by Jaffer A. Ahmad

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SAFETY NOTICE

Proper service and repair procedures are vital to the safe, reliable operation of all motor vehicles, as well as the personal safety of those performing repairs. This manual outlines procedures for servicing and repairing vehicles using safe, effective methods. The procedures contain many NOTES, CAUTIONS and WARNINGS which should be followed, along with standard procedures to eliminate the possibility of personal injury or improper service which could damage the vehicle or compromise its safety.

It is important to note that repair procedures and techniques, tools and parts for servicing motor vehicles, as well as the skill and experience of the individual performing the work vary widely. It is not possible to anticipate all of the conceivable ways or conditions under which vehicles may be serviced, or to provide cautions as to all possible hazards that may result. Standard and accepted safety precautions and equipment should be used when handling toxic or flammable fluids, and safety goggles or other protection should be used during cutting, grinding, chiseling, prying, or any other process that can cause material removal or projectiles.

Some procedures require the use of tools specially designed for a specific purpose. Before substituting another tool or procedure, you must be completely satisfied that neither your personal safety, nor the performance of the vehicle will be endangered.

Although information in this manual is based on industry sources and is complete as possible at the time of publication, the possibility exists that some car manufacturers made later changes which could not be included here. While striving for total accuracy, the authors or publishers cannot assume responsibility for any errors, changes or omissions that may occur in the compilation of this data.

PART NUMBERS

Part numbers listed in this reference are not recommendations by Haynes North America, Inc. for any product brand name. They are references that can be used with interchange manuals and aftermarket supplier catalogs to locate each brand supplier's discrete part number.

SPECIAL TOOLS

Special tools are recommended by the vehicle manufacturer to perform their specific job. Use has been kept to a minimum, but where absolutely necessary, they are referred to in the text by the part number of the tool manufacturer. These tools can be purchased, under the appropriate part number, from your local dealer or regional distributor, or an equivalent tool can be purchased locally from a tool supplier or parts outlet. Before substituting any tool for the one recommended, read the SAFETY NOTICE at the top of this page.

ACKNOWLEDGMENTS

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HOW TO USE THIS BOOK

Chilton's Total Car Care Manual 1970-89 Volvos is intended to teach you more about the inner workings of your car and save you money on its upkeep. The first two sections will be used the most, since they contain maintenance and tune-up information and procedures. The sections following concern themselves with more complex systems. Operating systems from engine through brakes are covered to the extent that we feel the average do-it-yourselfer should get involved. In certain cases, we cover more complex procedures that will benefit both the advanced do-it-yourselfer mechanic as well as the professional. For example, this book will explain such things as rebuilding the transmission. It should be advised, however, that the expertise required, and the investment in special tools makes this task uneconomical and impractical for the novice mechanic. On the simpler side, we will tell you how to change your own brake pads and shoes, replace spark plugs, perform routine maintenance, and many more jobs that will save you money, help you avoid problems, and give you personal satisfaction.

A secondary purpose of this book is for it to serve as a reference guide to owners who want to better understand their Volvo, communicate more meaningfully with their mechanic, or both. In this case, no tools at all are required. Just knowing what a particular repair job requires in parts and labor time will allow you to evaluate whether or not you are getting a fair price quote and help decipher itemized bills from a repair shop.

Before attempting any repairs or service on your Volvo, read through the entire procedure outlined in the appropriate section. This will give you the overall view of what tools and supplies will be required. There is nothing more frustrating than having to walk to the bus stop on Monday morning because you were short one gasket on Sunday afternoon. So read ahead and plan ahead. Each operation should be approached logically and all procedures thoroughly understood before attempting any work. Some special tools that may be required can often be rented from local automotive jobbers or places specializing in renting tools and equipment. Check the yellow pages of your phone book.

All sections contain adjustments, maintenance, removal and installation procedures, and overhaul procedures. When overhaul is not considered practical, we tell you how to remove the part that failed, and then how to install the new or rebuilt replacement. In this way, you at least save the labor costs.

Two basic mechanic's rules should be mentioned here. First, whenever the LEFT side of the Volvo or engine is referred to, it is meant to specify the DRIVER'S side of the Volvo. Conversely, the RIGHT side of the Volvo means the PASSENGER'S side. Second, all screws and bolts are removed by turning counterclockwise, and tightened by turning clockwise, unless otherwise specified.

Safety is always the most important consideration. Constantly be aware of the dangers involved in working on or around an automobile and take proper precautions to avoid the risk of personal injury or damage to the Volvo. See the subsection following entitled, "Servicing Your Vehicle Safely," and the SAFETY NOTICE on the acknowledgment page before attempting any service procedures.

Always read carefully the instructions provided. There are three commonly made mistakes in mechanical work:

1. **Incorrect order of assembly, disassembly or adjustment.** When taking something apart or putting it together, doing things in the wrong order usually just costs you extra time; however, it CAN break something. Read the entire procedure before beginning disassembly. Do everything in the order in which the instructions say you should, even if you can't immediately see a reason for it. When you are taking apart something that is very intricate (for example, a carburetor), you might want to draw a picture or use an instant camera to record how it looks when assembled at one point in order to make sure you get everything back in its proper position. We will supply exploded views whenever possible, but sometimes the job requires more attention to detail than an illustration provides. When making adjustments (especially tune-up adjustments), do them in order. One adjustment often affects another.
2. **Overtightening (or undertightening) nuts and bolts.** While it is more common for overtightening to cause damage, undertightening can cause a fastener to vibrate loose and cause serious damage, especially when dealing with aluminum parts. Pay attention to torque specifications and utilize a torque wrench in assembly. If a torque figure is not available, remember that if you are using the right tool to do the job, you will probably not have to strain yourself to get a fastener tight enough. The pitch of most threads is so fine that the tension you apply with the wrench will be multiplied many times in actual force on what you are tightening. A good example of how critical torque is can be seen in the case of spark plug installation, especially when you are putting the (steel) plug into an aluminum cylinder head. Too little torque can fail to crush the gasket, causing leakage of combustion gases and consequent overheating of the plug and engine parts. Too much torque can damage the aluminum threads or distort the plug, which changes the spark gap at the electrode. Since more and more manufacturers are using aluminum in their engine and chassis parts to save weight, a torque wrench should be in any serious do-it-yourselfer's tool box.

➡There are many commercial chemical products available for ensuring that fasteners won't come loose, even if they are not tightened just right (a very common brand is Loctite®). If you're worried about getting something together tight enough to hold, but loose enough to avoid mechanical damage during assembly, one of these products might offer substantial insurance. Read the label on the package and make sure the product is compatible with the materials, fluids, etc. involved before choosing one.

3. **Cross-threading.** This occurs when a part or fastener such as a bolt is forcefully screwed into a casting or nut at the wrong angle, causing the threads to become damaged. Cross-threading is more likely to occur if access is difficult. To avoid cross-threading, it helps to clean and lubricate fasteners, and to start threading with the part to be installed going straight in, using your fingers. If you encounter resistance, unscrew the part or fastener and start again at a different angle until the threads catch and it can be turned several times without much

effort. Keep in mind that many parts, especially spark plugs, use tapered threads so that gentle turning will automatically bring the item you are threading to the proper angle if you don't force it or resist a change in angle. Don't put a wrench on the part or fastener until it has been turned in a couple of times by hand. If you suddenly encounter resistance and the part or fastener has not seated fully, do not force it. Pull it back out and make sure it is clean and threading properly.

Always take your time and be patient; once you gain some experience, working on your Volvo will become an enjoyable hobby.

TOOLS AND EQUIPMENT

See Figures 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10

Having the right tools for the job is essential. Without the proper tools and equipment it is impossible, or at least unnecessarily frustrating, to properly service your vehicle. It would be impossible to catalog each and every tool needed to perform every procedure in this book. It would also be unwise for the amateur to rush out and buy an expensive set of tools on the theory that he may need one or more of them sometime.

The best approach is to proceed slowly, gathering together a good quality set of those tools that are used most frequently. Don't be misled by the low cost of bargain tools. It is far better to spend a little more for quality. Forged wrenches, 6 or 12-point sockets and fine tooth ratchets are by far preferable to their less expensive counterparts. As any good mechanic can tell you, there are few worse experiences than trying to work on a car with bad tools. Your monetary savings will not be worth the consequent cost of frustration and mangled knuckles.

Certain tools, plus a basic ability to handle tools, are required to get started. A basic mechanic's tool set, a torque wrench, and a Torx® bit set. Torx® bits are hex lobular drivers which fit both inside and outside on special Torx® head fasteners used in various places on Volvo vehicles.

Begin accumulating those tools that are used most frequently: those associated with routine maintenance and tune-up.

In addition to the normal assortment of screwdrivers and pliers, you should have the following tools for routine maintenance jobs (your Volvo uses metric fasteners):

- Metric wrenches, sockets and combination open end/box end wrenches in sizes from 3mm to 19mm; and a spark plug socket. If possible, buy various length socket drive extensions. One break in this department is that the metric sockets available in the U.S. will all fit the ratchet handles and extensions you may already have (1/4 in., 3/8 in., and 1/2 in. drive).
- Jackstands for support.
- Oil filter wrench.
- Funnel for pouring oil.
- Grease gun for chassis lubrication.
- Hydrometer for checking the (non-sealed free) battery.
- A container for draining oil.
- Many rags for wiping up the inevitable mess.

In addition to the above items there are several others that are not absolutely necessary but handy to have around. These include oil-absorbing material in case of spills, a long funnel for filling the transmission and the usual supply of lubricants, antifreeze and fluids. This is a basic list for routine maintenance, but only your personal needs and desires can accurately determine your list of necessary tools.

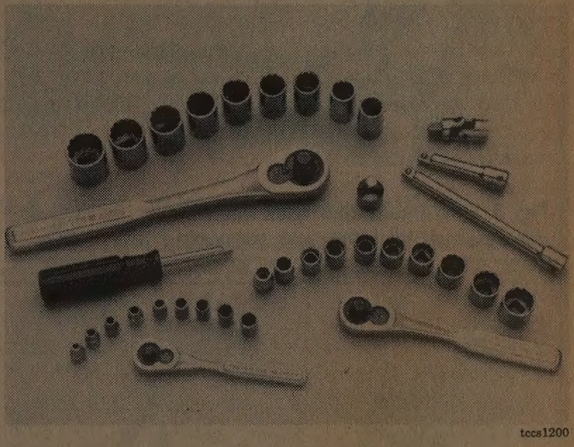
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Fig. 1 All but the most basic procedure will require an assortment of ratchets and sockets

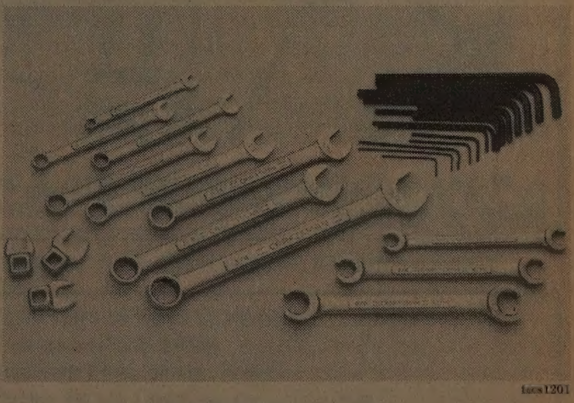
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Fig. 2 In addition to ratchets, a good set of wrenches and hex keys will be needed

The second list of tools is for tune-ups. While the tools involved here are slightly more sophisticated, they need not be outrageously expensive. There are several inexpensive tach/dwell meters on the market that work every bit as well for the average mechanic as an expensive professional model. Just be sure that the tachometer scale reads to at least 1200 rpm (preferably 1500 rpm), and that it works on 4 cylinder engines.

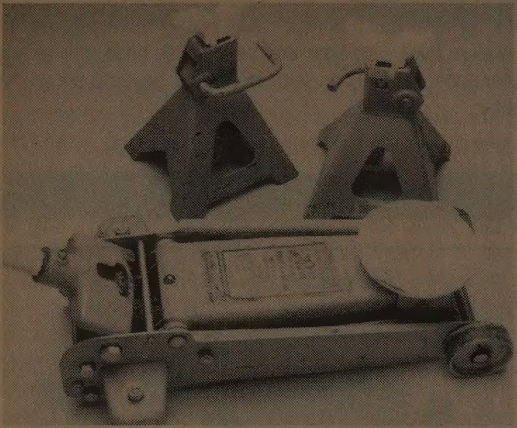
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Fig. 3 A hydraulic floor jack and a set of jackstands are essential for lifting and supporting your Volvo

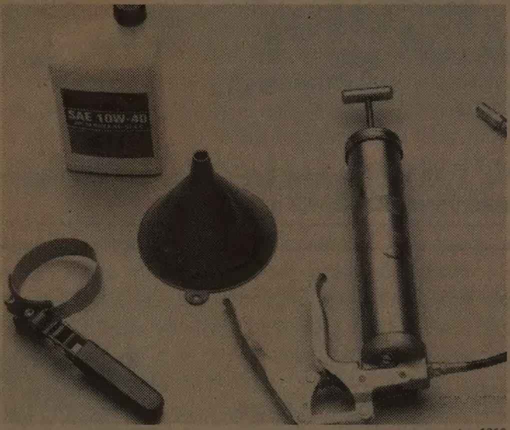

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Fig. 4 A few inexpensive lubrication tools will make regular service easier

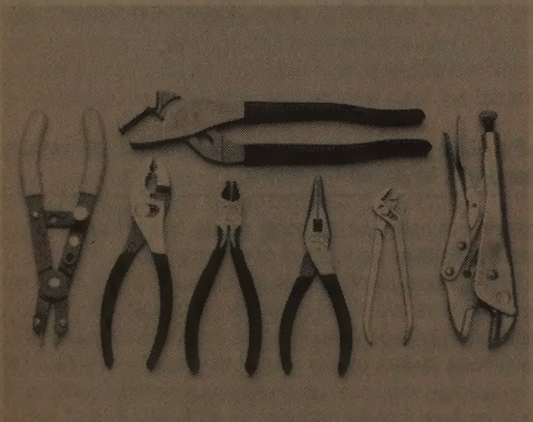
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Fig. 5 An assortment of pliers will be handy, especially for old rusted parts and stripped bolt heads

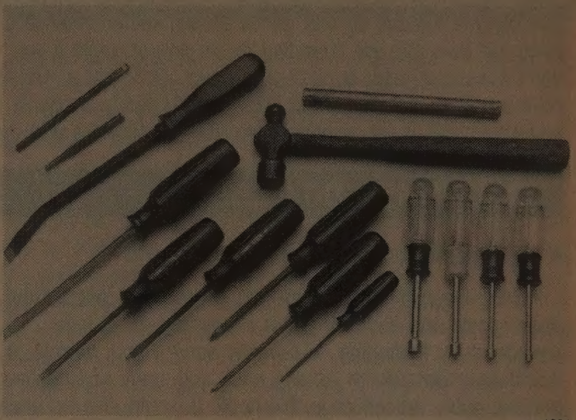
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Fig. 6 Various screwdrivers, a hammer, chisels and prybars are necessary to have in your toolbox

A basic list of tune-up equipment could include:

- Tach/dwell meter.
- Spark plug wrench or socket.
- Timing light (a DC light that is powered by the Volvo's battery is best, although an AC light that plugs into 110V house current will suffice at some sacrifice in brightness).
- Wire-type spark plug gauge and plug adjusting tools.
- Set of feeler blades.

In addition to these basic tools, there are several other tools and gauges you may find useful. These include:

- A compression gauge. The screw-in type takes longer to use, but eliminates the possibility of a faulty reading due to escaping pressure.
- A manifold vacuum gauge.
- A test light.
- An induction meter. This is used for determining whether or not there is current in a wire. These are handy for use if a wire is broken somewhere in a wiring harness.

As a final note, you will probably find a torque wrench necessary for all but the most basic work. The beam type models are perfectly adequate, although the newer click (breakaway)

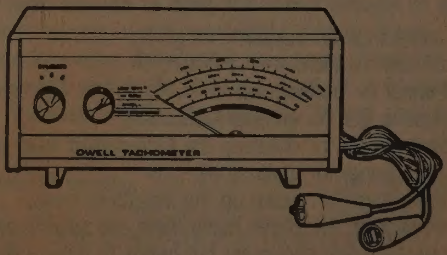

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Fig. 7 A common dwell/tachometer

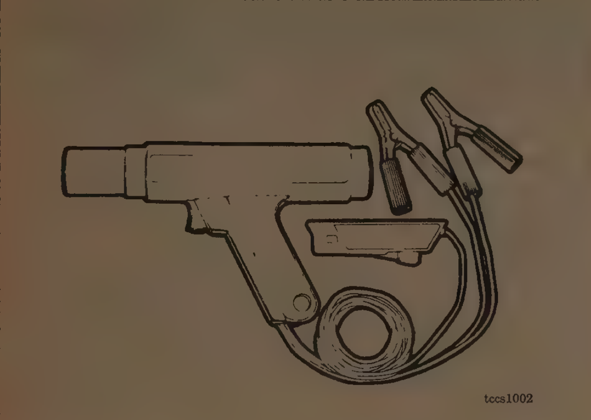
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Fig. 8 An inductive-type timing light

type are more precise and you don't have to crane your neck to see a torque reading in awkward situations. Breakaway torque wrenches are more expensive and will need to be recalibrated periodically.

A torque specification for each fastener will be given in the procedure in any case that a specific torque value is required. If no torque specifications are given, use the following values as a guide, based upon fastener size:

Bolts marked 6T

- 6mm bolt/nut: 5-7 ft. lbs. (7-10 Nm)
- 8mm bolt/nut: 12-17 ft. lbs. (16-23 Nm)
- 10mm bolt/nut: 23-34 ft. lbs. (31-46 Nm)
- 12mm bolt/nut: 41-59 ft. lbs. (56-80 Nm)
- 14mm bolt/nut: 56-76 ft. lbs. (76-103 Nm)

Bolts marked 8T

- 6mm bolt/nut: 6-9 ft. lbs. (8-12 Nm)
- 8mm bolt/nut: 13-20 ft. lbs. (18-27 Nm)
- 10mm bolt/nut: 27-40 ft. lbs. (37-54 Nm)
- 12mm bolt/nut: 46-69 ft. lbs. (62-94 Nm)
- 14mm bolt/nut: 75-101 ft. lbs. (102-137 Nm)

➡Special tools are occasionally necessary to perform a specific job or are recommended to make a job easier. Recommendation for their use has been kept to a minimum. When a special tool is indicated, it will be referred to by a manufacturer's part number, and, where possible, an illustration of the tool will be provided so that an equivalent tool may be used.

Some special tools are available commercially from major tool manufacturers; others can be purchased through your Volvo dealer. A list of tool suppliers and their addresses follows:

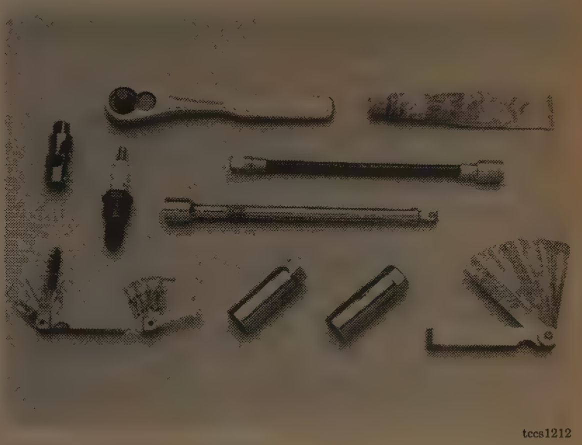
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Fig. 9 A variety of tools and gauges are needed for spark plug service

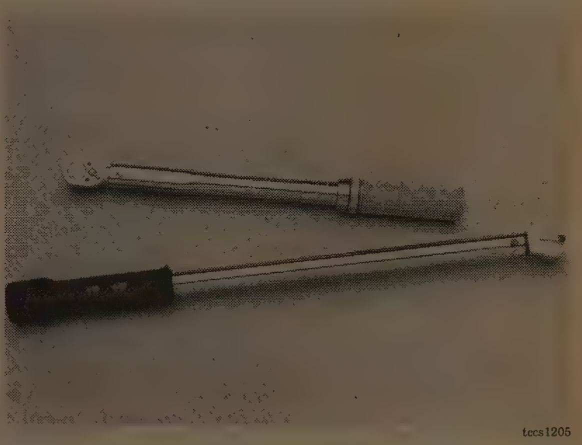
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Fig. 10 Many repairs will require the use of a torque wrench to assure the components are properly fastened

Volvo Cars of North America
Rockleigh Industrial Park
Rockleigh, New Jersey 07647
Robert Bosch Corp.
2800 S. 25th St.
Broadview, Illinois 60153
Snap-on Tools Corp.
Kenosha, Wisconsin 53141
CP/Matco Tools
4403 Allen Rd.
Stow, Ohio 44224

SERVICING YOUR VEHICLE SAFELY

It is virtually impossible to anticipate all of the hazards involved with automotive maintenance and service, but care and common sense will prevent most accidents.

The rules of safety for mechanics range from "don't smoke around gasoline," to "use the proper tool for the job." The trick to avoiding injuries is to develop safe work habits and take every possible precaution.

Do's

- Do keep a fire extinguisher and first aid kit within easy reach.
- Do wear safety glasses or goggles when cutting, drilling or prying, to prevent debris or foreign matter from getting in your eyes. If you wear prescription eyeglasses, wear also safety goggles or compatible safety glasses over your regular glasses.
- Do shield your eyes whenever you work around the battery. Batteries contain sulfuric acid; in case of contact with the eyes or skin, flush the area with water or a mixture of water and baking soda and get medical attention immediately.
- Do use jackstands for any under-car service. Jacks are for raising vehicles; jackstands are for making sure the vehicle stays raised until you want it to come down. Whenever the vehicle is raised, block the wheels remaining on the ground and set the parking brake.
- Do use adequate ventilation when working with any chemicals. Also, the dust from certain aftermarket brake linings (not original Volvo manufactured) may contain asbestos, and should not be breathed into the lungs. Even trace amounts of this hazardous material is known to cause cancer and lung disease following a lengthy incubation period.
- Do disconnect the negative battery cable when working on the electrical system. The secondary ignition system can contain extremely high voltage.
- Do follow manufacturer's directions whenever working with potentially hazardous materials. Both brake fluid and antifreeze are poisonous if taken internally.
- Do properly maintain your tools. Loose hammerheads, mushroomed punches and chisels, frayed or poorly grounded electrical cords, excessively worn screwdrivers, spread wrenches (open end), cracked sockets, slipping ratchets, or faulty droplight sockets can cause accidents.
- Do use the proper size and type of tool for the job being done.
- Do when possible, pull on a wrench handle rather than push on it. Adjust your stance to prevent a fall.
- Do be sure that adjustable wrenches are tightly adjusted on the nut or bolt and pulled so that the face is on the side of the fixed jaw.
- Do select a wrench or socket that fits the nut or bolt. The wrench or socket should sit straight, not cocked.
- Do strike squarely with a hammer — avoid glancing blows.
- Do set the parking brake and block the drive wheels if the work requires that the engine be running.

Don'ts

- Don't run an engine in a garage or anywhere else without proper ventilation — EVER! Carbon monoxide is poisonous; it takes a long time to leave the human body and you can build up a deadly supply of it in your system by simply breathing in a little every day. You may not realize you are slowly poisoning yourself. Always use power vents, windows, fans or open the garage doors.
- Don't work around moving parts while wearing a necktie or other loose clothing. Short sleeves are much safer than long, loose sleeves and hard-toed shoes with neoprene soles protect your toes and give a better grip on slippery surfaces. Jewelry such as watches, fancy belt buckles, beads or body adornment of any kind is not safe working around a vehicle. Long hair should be kept under a hat or cap.
- Don't use pockets for toolboxes. A fall or bump can drive a screwdriver deep into your body. Even a wiping cloth hanging from a back pocket can wrap around a spinning shaft or fan.
- Don't smoke when working around gasoline, cleaning solvent or other flammable material.
- Don't smoke when working around the battery. When the battery is being charged, it gives off explosive hydrogen gas.
- Don't use gasoline to wash your hands; there are excellent grease-cutting soaps available. Gasoline contains chemicals that are harmful to body. And gasoline removes protective natural oils from the skin, leaving it dry, flaking and ready to absorb more oil and grease.
- Don't service the air conditioning system unless you are equipped with the necessary tools and training. If necessary to discharge the refrigerant system, a recovery/recycling station must be used. The refrigerant is extremely cold and when exposed to the air, will instantly freeze any surface it comes in contact with, including your eyes. Although the R-12 refrigerant is normally non-toxic, it becomes a deadly poisonous gas in the presence of an open flame. One good whiff of the vapors from burning refrigerant can be fatal.
- Don't use screwdrivers for anything other than driving screws! A screwdriver used as a prying tool can snap when you least expect it, causing injuries. At the very least, you could ruin a good screwdriver.
- Don't use a bumper jack (that little ratchet, scissors, or pantograph jack supplied with the vehicle) for anything other than changing a flat! These jacks are only intended for emergency use on the road; they are NOT designed as a maintenance tool. If you are serious about maintaining your vehicle yourself, invest in a hydraulic floor jack of at least 1½ ton capacity, and at least two sturdy jackstands. Do not use cinder blocks which can crumble and suddenly crush under the weight of the vehicle while you are working on it.

SERIAL NUMBER IDENTIFICATION

In all correspondence with your Volvo dealer or when ordering spare parts, the vehicle type designation, chassis number, and, if applicable, the engine, transmission, and rear axle (final drive) numbers should be quoted for proper identification.

Vehicle Type Designation and Chassis Number

See Figures 11, 12, 13, 14 and 15

The vehicle model type (1800, 142, 144, 145, 164, 240, 242, 244, 245, 262, 264, 265, 740, 760 or 780) and chassis number appear at several locations on every Volvo. For purposes of this book, models sold in the early 1980s without number designation (ex: DL, GLT, Coupe) are considered members of the 200 Series of vehicles. The type designation and chassis number is stamped on the front door pillar on the right side of the car. Additionally, the numbers are stamped on a plate which is mounted under the hood on the right shock absorber tower.

For example, the vehicle type designation and chassis number may appear as VC 24445 L 1275965. The VC represents the manufacturer's code. Of the 24445, the first three digits, 244, indicate the model type (family is 240, model has 4 doors), while the last two digits indicate engine type and if the engine is fuel injected or uses a carburetor. The letter code indicates model year (in this case, "L" equals 1978), and the number following the letter code indicates location of the manufacturing plant that made this particular car. The final one to six digits comprise the vehicle's chassis number.

On models 1981 and newer, the U.S. standard 17 digit Vehicle Identification Number (VIN) is used. This number is most easily found on a plate mounted on the left side of the dashboard and visible through the windshield from the outside of the car. Again, it may also be found on the plate mounted on the right shock absorber tower.

It should be noted that although both styles of vehicle number (1970-80 and 1981-89) contain a letter code for model year, the codes are different before and after the 1980-81 change. For example, prior to 1981, the letter H denoted a 1977 model. In the longer, 17 digit VIN, H denotes a 1987 model. 1988 models are denoted by a J, and 1989 models by a K, as the letter I is not used.

Engine Identification

See Figure 16

Volvo identifies its engines by a type or family, using a combination of letters and numbers. Examples of a type number are B20B, B21F, or D24T. These family designations will be used throughout this book. Each engine within a particular family is further identified by its engine number. These engine numbers are coded to show emission type, transmission match (manual or automatic), and other detailed information. While you can work from this manual knowing only the engine type, replacement parts must be ordered using the exact engine number.

Start by looking at the vehicle number and selecting the engine type codes from the proper positions. Refer to the chart below to identify the engine family. Write the family designation down so that it's available any time you need it.

The engine number, part number and serial number are located on the left side of the engine on all models. On the B20, B30 engines, the number is located on the left side front of the engine. On the B21 and B23 series engines, the last three digits of the engine number are printed on a label on the timing belt cover. On the B230 series engines, the serial number is a six-digit number located on the camshaft drive cover and is also stamped on the cylinder block, behind the distributor.

On the B27, B28 engines, the number is located low on the block. The B280 engines have the number stamped on the cylinder block. The early type is located between the cylinder banks toward the rear, and the later type is located on the front right side, between the intake manifold and the water pump.

On the D24 series diesel engines, the engine number is stamped on the block underneath the vacuum pump.

Transmission and Rear Axle Identification

The transmission type designation, serial number and part number are stamped on a metal plate which is riveted to the

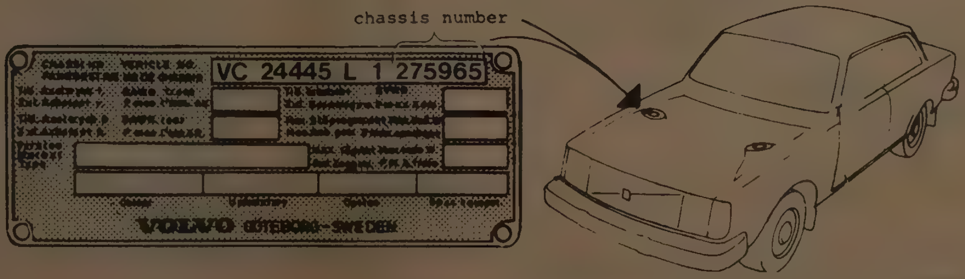
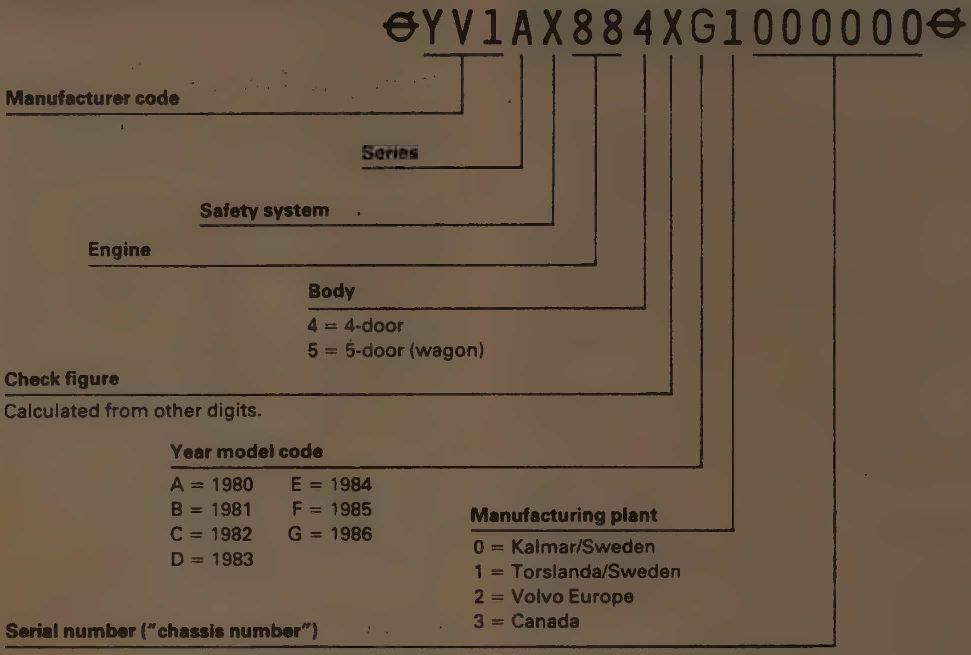
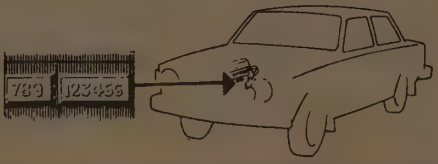


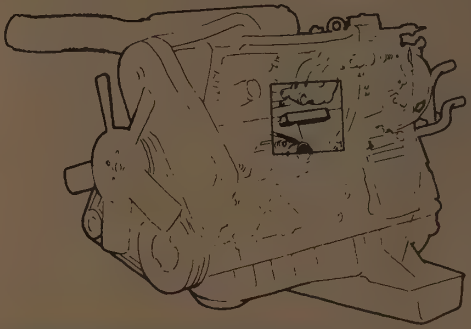
Fig. 11 Sample Vehicle Identification Number (VIN) — cars built before 1981


YV1AX884XG1000000
Manufacturer code
Series
Safety system
Engine
Body
4 = 4-door
5 = 5-door (wagon)
Check figure
Calculated from other digits.
Year model code
A = 1980
B = 1981
C = 1982
D = 1983
E = 1984
F = 1985
G = 1986
Manufacturing plant
0 = Kalmar/Sweden
1 = Torslanda/Sweden
2 = Volvo Europe
3 = Canada
Serial number ("chassis number")

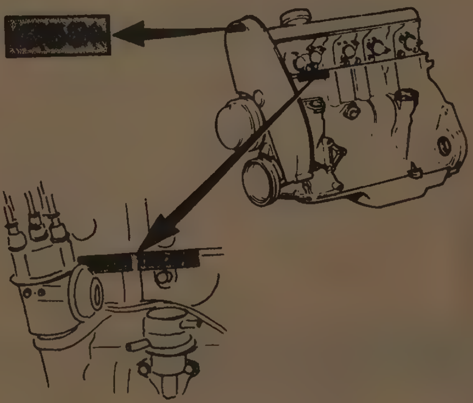
Sample Vehicle Identification Number for cars built 1981 and later years



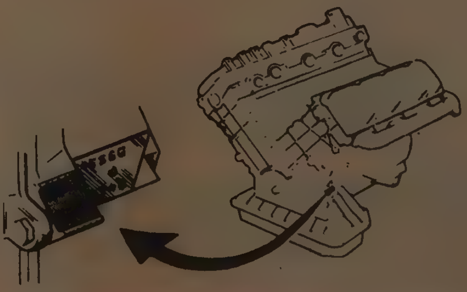
B20, B30 overhead valve engine serial number location



Diesel engine serial number location

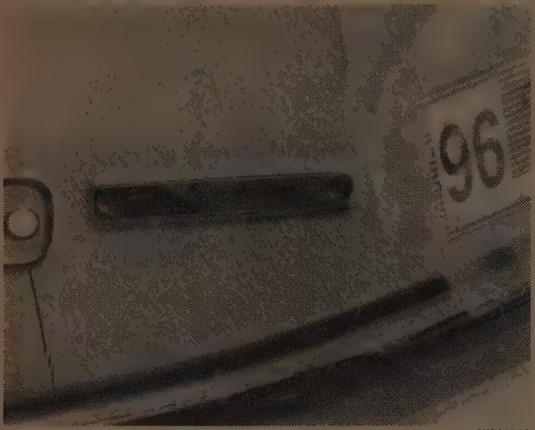


B21 and B23 series engine serial number location. The last three digits of the serial number are printed on a label on the timing belt cover



B28F V-6 engine serial number location. B27F similar

Fig. 12 Vehicle identification and serial number information — 1981 and newer models



87861309

Fig. 13 The 17-digit VIN code on this 1985 model can be seen through the windshield on the driver's side

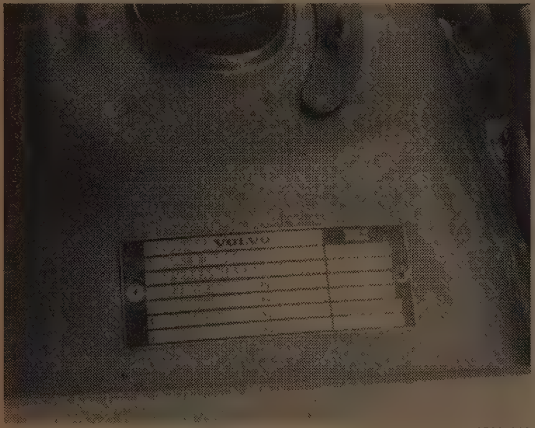


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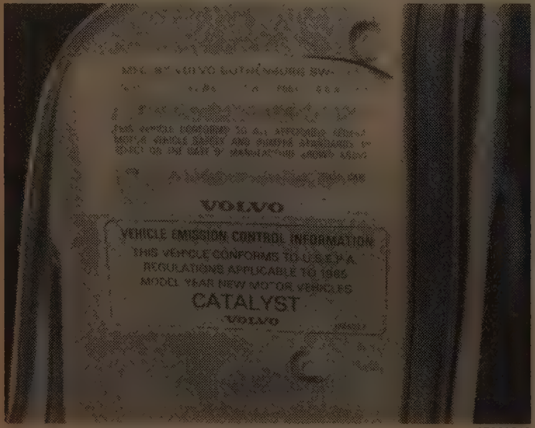
Fig. 14 The VIN code is also stamped on a plate mounted on the right shock absorber tower


VOLVO
VEHICLE EMISSION CONTROL INFORMATION
THIS VEHICLE CONFORMS TO U.S.E.P.A.
REGULATIONS APPLICABLE TO 1985
MODEL YEAR NEW MOTOR VEHICLES
CATALYST
VOLVO

87861348

Fig. 15 The VIN code is also printed along with other vital information of the right side door pillar

87861311

Fig. 16 This B21F Turbo engine is identifiable by the label affixed to the timing belt cover

underside of the case on manual transmissions or the left side on automatic transmissions.

The final drive ratio, part number, and serial number for the rear axle are stamped on a metal plate which is riveted to the left-hand side of the differential case. Again, when these numbers are located, they should be written down for future reference.

Engine Identification

Year	Model	Engine Code Within Vehicle Number	Engine Series Identification	No. of Cylinders	Engine Displacement cu. in. (cc/liter)
1970	142	ENGINE DESIGNATION STAMPED ON SIDE OF BLOCK	B20B	4	122 (1990/2.0)
	144		B20B	4	122 (1990/2.0)
	145		B20B	4	122 (1990/2.0)
	164		B30A	6	183 (2978/3.0)
	1800E		B20E	4	122 (1990/2.0)
1971	142		B20B/B20F*	4	122 (1990/2.0)
	144		B20B	4	122 (1990/2.0)
	145		B20B	4	127 (1990/2.0)
	164		B30A	6	183 (2978/3.0)
	1800E		B20E	4	122 (1990/2.0)
1972	142		B20B/B20F*	4	122 (1990/2.0)
	144		B20B/B20F*	4	122 (1990/2.0)
	145		B20B/B20F*	4	122 (1990/2.0)
	164		B30A	6	183 (2978/3.0)
	164 E		B30F	6	183 (2978/3.0)
	1800 E		B20E	4	122 (1990/2.0)
	1800 ES		B20E	4	122 (1990/2.0)
1973	142		B20F	4	122 (1990/2.0)
	144		B20F	4	122 (1990/2.0)
	145		B20F	4	122 (1990/2.0)
	164		B30F	6	183 (2978/3.0)
	1800 ES		B20E	4	122 (1990/2.0)
1974	142		B20F	4	122 (1990/2.0)
	144		B20F	4	122 (1990/2.0)
	145		B20F	4	122 (1990/2.0)
	164		B30F	6	183 (2978/3.0)
1975	164		B30F	6	183 (2978/3.0)
	242		B20F	4	122 (1990/2.0)
	244		B20F	4	122 (1990/2.0)
	245		B20F	4	122 (1990/2.0)
1976-79	242	45	B21F	4	130 (2127/2.2)
	244	45	B21F	4	130 (2127/2.2)
	245	45	B21F	4	130 (2127/2.2)
	262	65	B27F	6	162 (2660/2.7)
	264	65	B27F	6	162 (2660/2.7)
	265	65	B27F	6	162 (2660/2.7)

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Engine Identification (cont.)

Year	Model	Engine Code Within Vehicle Number	Engine Series Identification	No. of Cylinders	Engine Displacement cu. in. (cc/liter)
1980	DL	45	B21F	4	130 (2127/2.2)
	GL	45	B21F	4	130 (2127/2.2)
	GT	45	B21F	4	130 (2127/2.2)
	GLE	69	B28F	6	174 (2849/2.9)
	Coupe	69	B28F	6	174 (2849/2.9)
	Diesel	77	D24	6	145 (2383/2.4)
1981	DL	45	B21F	4	130 (2127/2.2)
	DL	41 (optional)	B21F-mpg	6	130 (2127/2.2)
	GL	45	B21F	4	130 (2127/2.2)
	Diesel	77	D24	6	145 (2383/2.4)
	GLT	47	B21F-Turbo	4	130 (2127/2.2)
	GLE	69	B28F	6	174 (2849/2.9)
	Coupe	69	B28F	6	174 (2849/2.9)
1982	DL	45	B21F	4	130 (2127/2.2)
	DL①	41	B21A	4	130 (2127/2.2)
	GL	45	B21F	4	130 (2127/2.2)
	GL	77	D24	6	145 (2383/2.4)
	GL①	84	B23E	4	140 (2320/2.3)
	GLT	47	B21F-Turbo	4	130 (2127/2.2)
	GLT	45	B21F	4	130 (2127/2.2)
	GLT①	84	B23E	4	140 (2320/2.3)
	GLE	69	B28F	6	174 (2849/2.9)
1983	DL	88	B23F	4	140 (2320/2.3)
	DL Turbo	47	B21F-Turbo	4	130 (2127/2.2)
	DL Diesel	77	D24	6	145 (2383/2.4)
	DL①	41	B21A	4	130 (2127/2.2)
	GL	88	B23F	4	140 (2320/2.3)
	GL Diesel	77	D24	6	145 (2383/2.4)
	GL①	84	B23E	4	140 (2320/2.3)
	GLT①	84	B23E	4	140 (2320/2.3)
	GLT Turbo	47	B21F-Turbo	4	130 (2127/2.2)
	760 GLE	69	B28F	6	174 (2849/2.9)
	Turbo Diesel	76	D24-Turbo	6	145 (2383/2.4)
1984	DL	88	B23F	4	140 (2320/2.3)
	DL①	44	B21A	4	130 (2127/2.2)
	GL	88	B23F	4	140 (2320/2.3)
	Turbo	47	B21F-Turbo	4	130 (2127/2.2)
	DL/GL Diesel	77	D24	6	145 (2383/2.4)
	740 GLE	88	B23F	4	140 (2320/2.3)
	Turbo	87	B23F-Turbo	4	130 (2127/2.2)
	760 GLE	69	B28F	6	174 (2849/2.9)
	Turbo	87	B23F-Turbo	4	140 (2320/2.3)
	Turbo Diesel	76	D24-Turbo	6	145 (2383/2.4)

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Engine Identification (cont.)

Year	Model	Engine Code Within Vehicle Number	Engine Series Identification	No. of Cylinders	Engine Displacement cu. in. (cc/liter)
1985	Turbo	47	B21F-Turbo	4	130 (2127/2.2)
	DL	88	B230F	4	140 (2320/2.3)
	GL	88	B230F	4	140 (2320/2.3)
	DL/GL Diesel	77	D24	6	145 (2383/2.4)
	740 GLE	88	B230F	4	140 (2320/2.3)
	Turbo	87	B230F-Turbo	4	140 (2320/2.3)
	GLE TD	76	D24-Turbo	6	145 (2383/2.4)
	760 GLE	69	B28F	6	174 (2849/2.9)
	Turbo	87	B230F-Turbo	4	140 (2320/2.3)
	GLE TD	76	D24-Turbo	6	145 (2383/2.4)
1986	240 DL	88	B230F	4	140 (2320/2.3)
	GL	88	B230F	4	140 (2320/2.3)
	740 GL	88	B230F	4	140 (2320/2.3)
	GLE	88	B230F	4	140 (2320/2.3)
	Turbo	87	B230F-Turbo	4	140 (2320/2.3)
	GLE TD	76	D24-Turbo	6	145 (2383/2.4)
	760 GLE	69	B28F	6	174 (2849/2.9)
	Turbo	87	B230F-Turbo	4	140 (2320/2.3)
	GLE TD	76	D24-Turbo	6	145 (2383/2.4)
1987	240 DL	88	B230F	4	140 (2320/2.3)
	GL	88	B230F	4	140 (2320/2.3)
	740 GL	88	B230F	4	140 (2320/2.3)
	GLE	88	B230F	4	140 (2320/2.3)
	Turbo	87	B230F-Turbo	4	140 (2320/2.3)
	760 GLE	69	B280F	6	174 (2849/2.9)
	Turbo	87	B230F-Turbo	4	140 (2320/2.3)
	780	69	B280F	6	174 (2849/2.9)
1988–89	240 DL	88	B230F	4	140 (2320/2.3)
	GL	88	B230F	4	140 (2320/2.3)
	740 GL	88	B230F	4	140 (2320/2.3)
	GLE	88	B230F	4	140 (2320/2.3)
	740 GLE 16-valve	89	B234F	5	140 (2320/2.3)
	Turbo	87	B230F-Turbo	4	140 (2320/2.3)
	760 GLE	69	B280F	6	174 (2849/2.9)
	Turbo	87	B230F-Turbo	4	140 (2320/2.3)
	780	69	B280F	6	174 (2849/2.9)

*optional motor
① Canada only

87861C07

ROUTINE MAINTENANCE

Volvo was one of the first car manufacturers with enough confidence in their product to install an odometer which can register 999,999.9 miles. While not every Volvo is destined to join the million mile club, the average car's life will be greatly increased if the owner is vigilant in performing regularly scheduled maintenance procedures.

Obviously, if the only time you peek under the hood is when something doesn't seem to be working right, you are flirting with disaster. Sooner or later something is bound to go thump on a rain-swept night, leaving you stranded along the road.

Consult the maintenance interval chart at the end of this section or use the one in your owner's manual and perform the following procedures in conjunction with the time or mileage intervals given. Remember that the intervals shown are maximums and should not be exceeded. Various items may need more frequent service or maintenance depending on where and how your Volvo is driven.

Air Cleaner

Service the air cleaner according to the maintenance interval chart in this section. When operating the vehicle in extremely dusty areas, in areas of high industrial pollution, or in mostly low-speed city driving, the element should be changed more frequently than the given interval. Inspect the air filter at every tune-up. A clogged air cleaner will restrict air passage into the combustion chambers of the engine. This means that a less than normal amount of air will be mixed with the fuel, which will richen the air/fuel mixture and cause poor engine performance and excessive fuel consumption.

REMOVAL & INSTALLATION

Carbureted Vehicles

142, 144, 145, AND 164 MODELS

The element is removed from the air cleaner by disconnecting the hose clamp from the air preheating unit and unsnapping the clips holding the air cleaner housing halves together. The old element is then lifted out and new one is lowered in with the word **UP** on the element facing up. When securing the air cleaner housing halves together, take care not to damage the thermostat body for the intake air.

Fuel Injected Vehicles

164 MODELS

On fuel-injected 164 series Volvos, the clips securing the cover to the air cleaner must be undone and the old element removed. When refitting the cover to the air cleaner, make sure that the arrow points coincide.

142, 144, AND 145 MODELS (1970-73)

On these models, the air cleaner is a one piece disposable unit. Since the elements cannot be removed from the air cleaner, the entire unit must be replaced.

To remove the air cleaner, turn the front wheels fully to the right, loosen and move the expansion tank for the cooling system to one side, disconnect the inlet duct hose and unfasten the attaching bolts which hold the air cleaner. Install the new air cleaner, reinstall and tighten the bolts, and reinstall the air inlet hose. Reposition and secure the coolant expansion tank.

142, 144, AND 145 MODELS (1974)

➧ See Figure 17

On these models the air cleaner is located beneath the air-fuel control unit for the fuel injection system. To remove the air cleaner element you must remove the air-fuel control unit: this is not a job for an inexperienced or fledgling mechanic.

To remove the air cleaner element, loosen the clamp and remove the rubber bellows from the top of the air-fuel control unit. Then disconnect the electrical connection at the air-fuel control unit and unlatch the retainers. Lift out the upper part of the air cleaner with the air-fuel control unit and replace the air cleaner element. Carefully re-assemble the air cleaner/air-fuel control unit, remembering to secure the clips, reattach the electrical connector and re-install the rubber bellows.

1800E AND 1800ES MODELS

On all 1800E and 1800ES models, the radiator grille must first be removed to gain access to the air cleaner. Remove the grille clips by inserting pliers between the ribs of the grille and lifting up on the front end of the clips. Push each clip into its hole and remove the grille. Unscrew the wing nut on the air cleaner cover and remove the element.

242, 244, AND 245 MODELS (1975)

The air filter is replaced in the same manner as on the 1974 fuel injected 142, 144 and 145 models. See above for procedures.

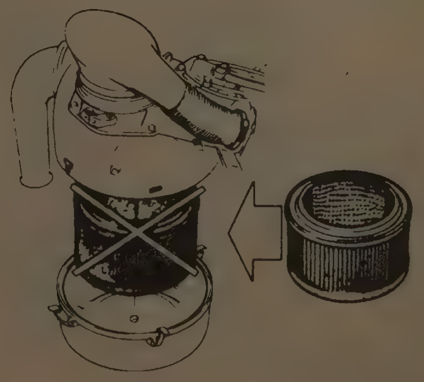

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Fig. 17 Air cleaner mounting — 1974 142, 144 and 145 fuel injected models

242, 244, AND 245 MODELS (1976)

➧ See Figures 18, 19, 20 and 21

The air cleaner is located to the left of the radiator. The element can be removed by unsnapping the clips retaining the air cleaner cover and separating the cover halves. Make sure the cover is properly seated and sealed when re-assembling.

262, 264 AND 265 MODELS

➧ See Figure 22

The air filter is housed in the large, flat canister on top of the engine. To remove the filter elements, disconnect the air hose from the top of the air cleaner, disconnect the rubber bellows between the air cleaner and the air-fuel control unit, remove the three attaching bolts and remove the air cleaner. Remove the filter element by unsnapping the clips and separating the air cleaner halves. Install a new element and reassemble, making sure that all the pieces fit properly and all hardware is re-installed.

Fig. 18 Unclip the air box hold-down clips located beside the air flow sensor and fuel distributor to access the air cleaner element

Fig. 19 Lift up the lid enough to pull out the element

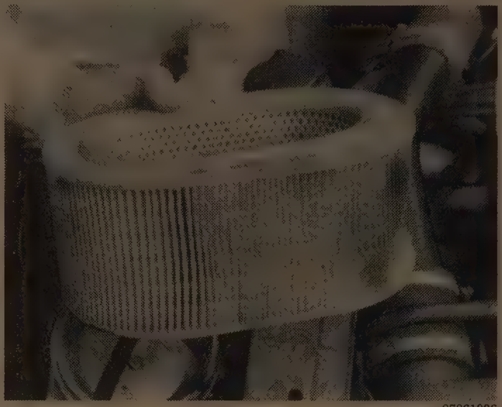

Fig. 20 Inspect the element at every tune-up for cleanliness. Routinely change it at service intervals or sooner if necessary

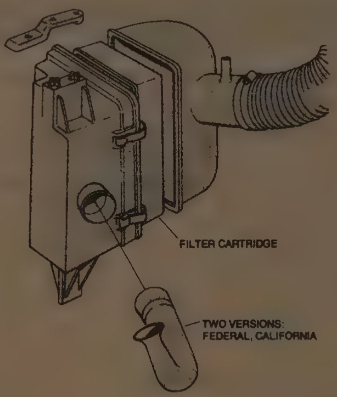

Fig. 21 Exploded view of a common air cleaner assembly — 1976 and later 242, 244, 245 models; 1980 and later GL, GT, DL models

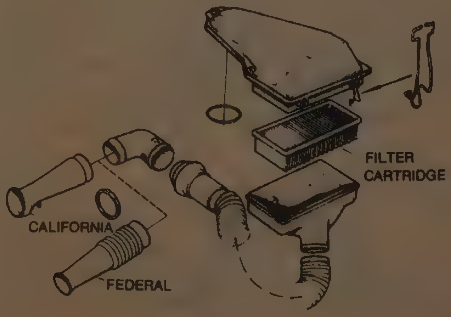

Fig. 22 Exploded view of a common air cleaner assembly — 1980 and later 262, 264, 265 models; GLE, Coupe, and 760 GLE similar

GL, GT, AND DL MODELS

The air cleaner element on these models is located to the left of the radiator. Unsnap the clips and separate the air cleaner housing halves to replace the element.

GLE, COUPE AND 760 GLE MODELS

➧ See Figure 22

Air cleaner element removal and installation is the same as on 262, 264, and 265 models. Refer to the procedure earlier in this section.

GLT AND TURBO MODELS

➧ See Figure 23

The air cleaner is located to the right of the radiator. Unsnap the clips and separate the air cleaner housing halves to service the element.

➡Turbocharged engines are very sensitive to proper airflow; you may wish to check or replace the air filter element more frequently than the manufacturer recommends.

DIESEL ENGINES

➧ See Figure 24

The air cleaner is located on the right fender well. Remove the rubber bellows hose from the air cleaner and unsnap the clips holding the air cleaner halves together to remove the element.

➡Diesel engines are very sensitive to proper airflow; you may wish to check or replace the air filter element more frequently than the manufacturer recommends.

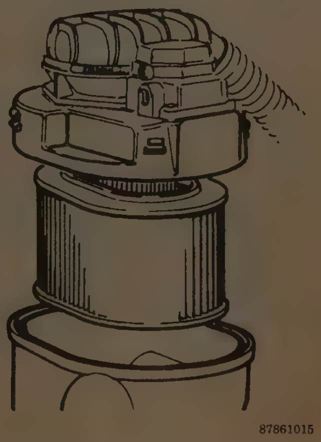

Fig. 23 Air cleaner assembly — GLT and Turbo models

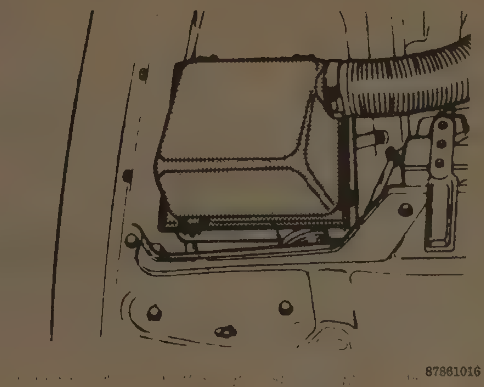

Fig. 24 Common diesel model air cleaner

Fuel Filter

REPLACEMENT

Carbureted Engines

✲✲CAUTION

Never smoke when working around gasoline! Avoid all sources of sparks or ignition. Gasoline vapors are EXTREMELY volatile!

On all carbureted Volvos, the fuel filter is to be removed and cleaned every six months or 6000 miles (9662 km). The filter is located integral with the fuel pump in the driver's side of the engine. To remove the filter on B20B engines, loosen the retaining screws and lift off the cover. To remove the filter on B30A engines, unscrew the plug and filter assembly on the side of the fuel pump. The filter can be cleaned in a low-volatility, petroleum-based solvent such as kerosene,but replacement is better. After replacing the clean element, install the cover and retaining screw on B20B engines, and after installing the plug and filter assembly on B30A engines, run the engine at fast idle and check for fuel leaks. Replace the gasket if any fuel seepage is evident.

Mechanical Fuel Injection

➧ See Figure 25

✲✲CAUTION

Never smoke when working around gasoline! Avoid all sources of sparks or ignition. Gasoline vapors are EXTREMELY volatile!

On these models the fuel filter is located under the hood on the left side of the firewall. It is a large cylinder with threaded couplings on both ends.

These models are equipped with a mechanical Continuous Injection (CI) system, which maintains constant pressure within the lines, even when the engine is not running. When changing the fuel filter, have a container handy to catch the fuel which will squirt out or wrap a rag around the fittings before loosening them. Do not smoke while changing the filter and do not attempt to change the filter when the engine is warm. The filter is removed by carefully unfastening the lines and removing the filter from its attaching bracket. When installing a new filter, make sure that arrow on the filter points in the direction of fuel flow.

Electronic Fuel Injection

✽✽CAUTION

Never smoke when working around gasoline! Avoid all sources of sparks or ignition. Gasoline vapors are EXTREMELY volatile!

ALL MODELS THROUGH 1981

➧ See Figure 26

The filter is located beneath the car, next to the fuel tank. Prior to removal of the filter, clean the fuel lines and the surrounding area to prevent dirt from entering the fuel systems during the change. Remove the fuel lines from the filter one at a time and pinch each shut to prevent fuel from spilling out. Discard the old filter and replace it with a new one. When installing the new filter, make sure that the arrow on the filter points in the direction of flow. After installation, run the engine at fast idle and check for leaks.

➡On some 6-cylinder models, the fuel filter is located with the fuel pump in a swingdown holder: remove the single attaching screw at the rear of the holder and allow it to hang down before attempting to remove the fuel filter.

1982-89 MODELS

➧ See Figures 27, 28, 29, 30, 31 and 32

These fuel filters are found inside a metal bracket under the left rear of the car. Before changing the fuel filter, loosen or remove the gas cap; this will equalize pressure within the system. Use two wrenches (this prevents the filter from turning) to disconnect the fuel lines at the filter. Remove the bolts holding the bracket to the car and carefully lower the assembly.

➡Use a rag wrapped around the fittings to minimize fuel spillage. Have a container ready when loosening connections. The fuel in the system (not the tank) will drain out.

Remove the clamp which holds the filter and transfer the clamp to the new filter, paying attention to the direction of flow as shown by the arrow on the new filter. Fuel flows FROM the tank TO the engine. Install the new filter with its clamp onto the bracket and connect the fuel lines. Make sure the copper seals are correctly installed and that all connections are tight. Reinstall or tighten the gas cap.

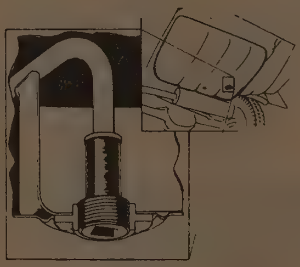

Fig. 26 Fuel tank pick-up screen — all models through 1975, as well as some 1976

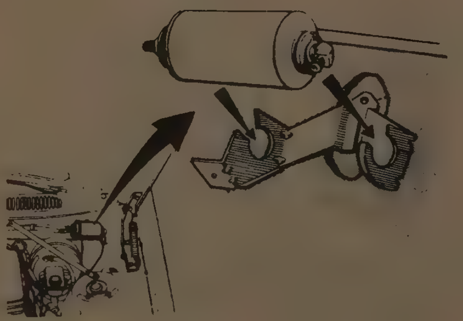

Fig. 25 Common fuel filter location and mounting — continuous mechanical fuel injection (CI) system-equipped vehicles

Fig. 27 Wrap a rag around the coupling and loosen using the correct size metric wrenches

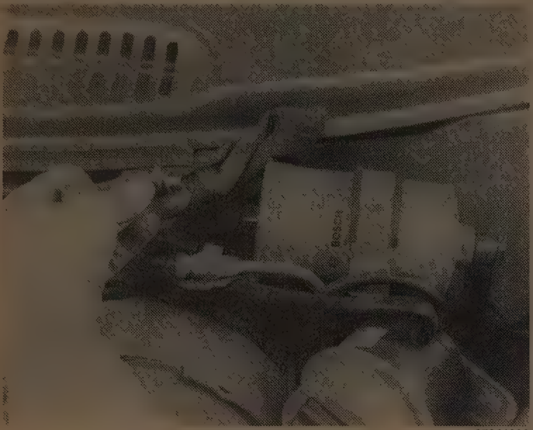

Fig. 28 Set aside the line — take care not to lose the special washer

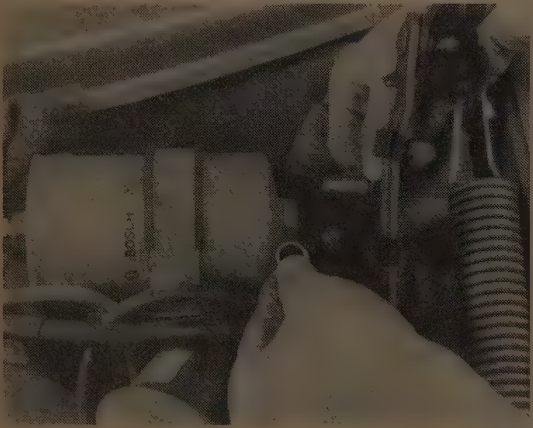

Fig. 29 Remove the fitting from the other side, again taking care to retain the special washer

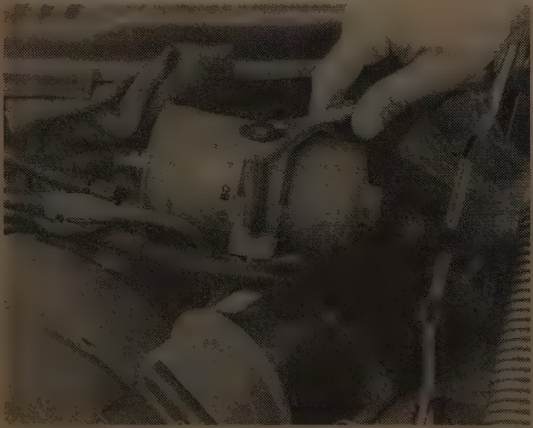

Fig. 30 Loosen the hold-down clamp enough to allow the filter to slide out

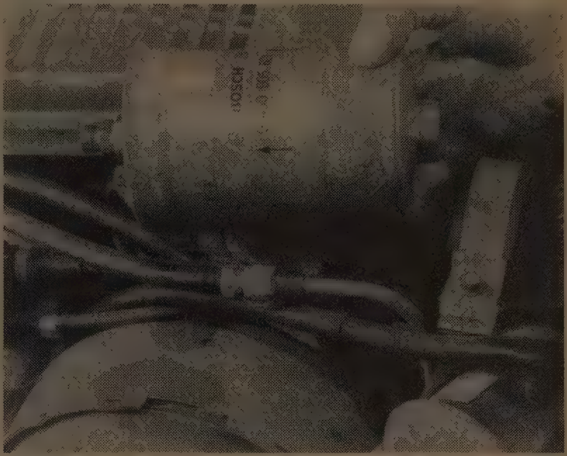

Fig. 31 Remove the detached fuel filter from the vehicle

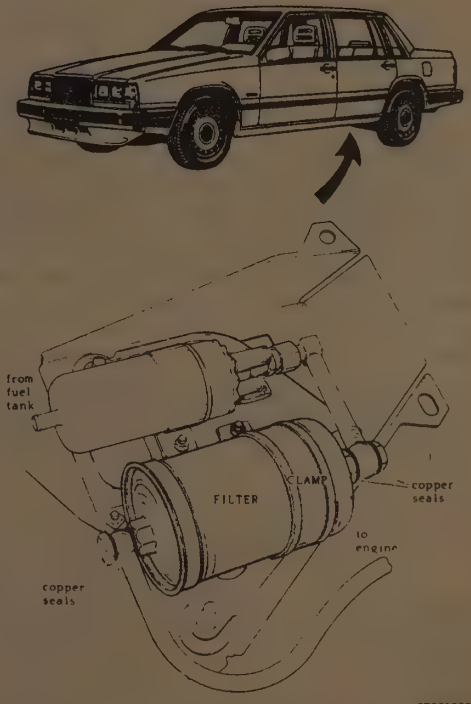
from fuel tank
FILTER
CLAMP
copper seals
to engine
copper seals
87861020

Fig. 32 Gasoline fuel filter location — 1982-89 200 series and 1983-89 700 series

FUEL TANK PICK-UP SCREEN/FILTER SERVICE

➧ See Figure 33

✻✻CAUTION

Never smoke when working around gasoline! Avoid all sources of sparks or ignition. Gasoline vapors are EXTREMELY volatile!

All models through 1975 are equipped with a fuel pick-up screen which is accessible after removing the countersunk plug in the bottom of the fuel tank with a drain plug wrench. For 1970-72 models, Volvo does not recommend regularly scheduled screen service. On 1973 and later models the screen should be removed and cleaned every 12,000 miles (19,324 km). Even though Volvo does not recommend cleaning the pick-up screen on 1970-72 models, it would be wise to remove and clean the screen periodically to insure sufficient fuel flow.

✻✻CAUTION

It is advisable that the tank be as near to empty as possible, to avoid spillage of highly flammable gasoline. Have a container of sufficient capacity on hand.

Pull the filter off the pick-up tube and soak it in solvent. When replacing the filter on the tube, make sure that it is centered on the tube so as not to restrict the fuel flow.

Beginning in 1976, some models are equipped with an in-tank pump which has a fuel filter attached to its bottom. This filter is accessible by removing the fuel tank pump cap and withdrawing the pump and filter. The filter should be replaced every 60,000 miles (96,618 km). All 1977 and later models except the diesel are equipped with this type of filter.

➡Some 1976 models are equipped with a fuel tank pick-up screen.

Diesel Engine

The diesel engine uses a canister type fuel filter which for models built 1982 and earlier should be replaced every 15,000 miles (24,155 km) under normal driving conditions, and more often under hard driving or severe climate conditions. The filter is located on the left side rear of the engine. For diesel cars built after 1983, Volvo recommends replacing the fuel filter at 30,000 mile (48,309 km) intervals.

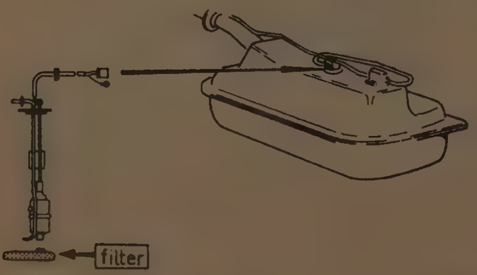

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Fig. 33 Fuel tank mounted fuel filter — some 1976 models, as well as all 1977 and later models (except diesel)

1. Position an oil filter band wrench as high as possible on the fuel filter and loosen the filter.
2. Unscrew and remove the filter, being careful not to allow the fuel in the filter to spill out.
3. Apply diesel oil to the rubber gasket on the new filter and install the filter.
4. Tighten the filter by hand until the rubber gasket makes a tight fit, then tighten the filter 1/4 turn more by hand.

➡Do not use a band wrench or any other tool to tighten the fuel filter.

5. Start the engine and check for fuel leaks around the filter gasket. If the rubber gasket is not seated properly, air will be sucked into the system and adversely affect engine operation.

BLEEDING THE FUEL SYSTEM

Bleeding the fuel system is not required. After the filter or other fuel system parts have been replaced, simply crank the engine until it starts and accelerate a few times until the engine runs smoothly. This is also true if the car has simply run out of fuel; no bleeding is required.

DRAINING THE DIESEL FILTER

Diesel fuel tends to collect water, especially if the vehicle is routinely driven with a low or nearly empty fuel tank. Since oil — in this case diesel fuel — floats on water, the canister type filter will allow the accumulated water to sink to the bottom of the filter. It is important to drain the canister at regular intervals. Volvo recommends the water be drained every 7500 miles (12,077 km). It is such a simple procedure that is well worth doing every time you change the engine oil and filter.

1. Position a collection pan under the drain screw (2) at the bottom of the filter.
2. Loosen the bleeder screw (1) several turns.
3. Loosen the drain screw (2) and allow the filter to drain until only clean fuel flows out, then tighten the drain screw.
4. Tighten the bleeder screw.

Battery

➧ See Figures 34, 35 and 36

Loose, dirty, or corroded battery terminals are a frequent cause of no-start conditions. Every three months or so, remove the battery terminals and clean them, giving them a light coating of petroleum jelly when you are finished. This will help to prevent corrosion.

Check the battery cables for signs of wear or chafing and replace any cable or terminal that looks marginal. Battery terminals can be easily cleaned; inexpensive cleaning tools are an excellent investment that will pay for themselves many times over. They can usually be purchased from any well-

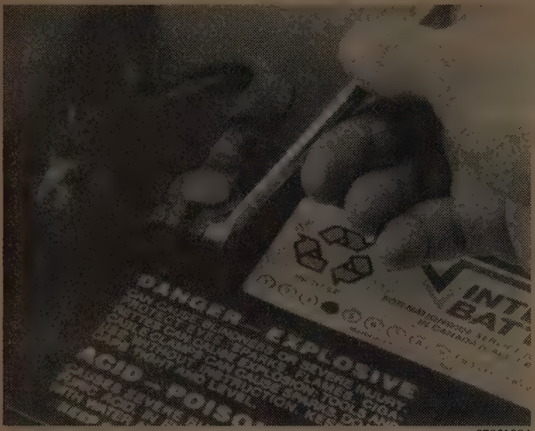

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Fig. 34 A box-end wrench provides a good hold on the clamp nut without rounding it off

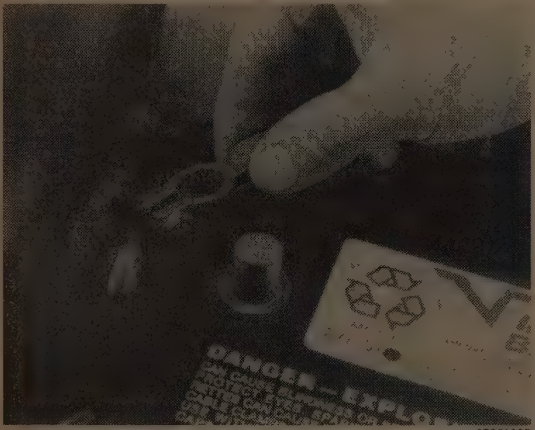

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Fig. 35 Position the cable end away from the battery terminal when detached

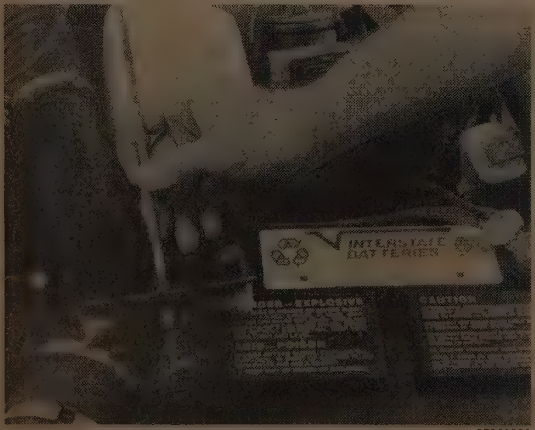

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Fig. 36 Install the battery hold-down securely to prevent the battery from moving while the car is in operation

equipped auto parts store or parts department. The accumulated white powder and corrosion can be cleaned from the top of the battery with an old toothbrush and a solution of baking soda and water.

Unless you have a sealed, maintenance-free battery, check the electrolyte (fluid) level frequently. Be sure that the vent holes in each cell cap are not blocked by grease or dirt. The vent holes allow hydrogen gas, formed by the chemical reaction in the battery, to escape safely.

Check the battery electrolyte level at least once a month, more often in hot weather or during periods of extended operation. The level should be maintained between the upper and lower levels marked on the battery case, or to the split ring within the well in each cell. If the electrolyte level is low, distilled water should be added until the proper level is reached. Tap water is to be avoided if possible; the minerals it contains can shorten battery life by reacting with the metal plates inside the battery. Each cell is completely separate from the others, so each cell must be filled individually. It's a good idea to add the distilled water with a squeeze bulb to avoid having electrolyte (sulfuric acid) splash out.

➡Cars that are regularly driven at highway speeds over moderate to long distances may require battery service more frequently. Constant charging of the battery will cause some water to evaporate.

At least once a year check the specific gravity of the battery electrolyte. It should be between 1.22 and 1.28 at room temperature. A reading of 1.00 or slightly above indicates nothing but water within the battery. The electrical process has stopped and its time for a new battery. You cannot successfully add acid to a used battery. If water is added in freezing weather, the vehicle should be driven several miles to allow the water to mix with the electrolyte and prevent freezing.

If the battery becomes corroded, or if electrolyte should splash out during additions of water, a mixture of baking soda and water will neutralize the acid. This should be washed off with cold water after making sure that the cell caps are tight. Battery fluid is particularly nasty to painted surfaces; work carefully to avoid spillage on fenders and other painted bodywork.

If a charging is required while the battery is in the car, disconnect the battery cables, negative (ground) cable first. If you have removed the battery from the vehicle for charging, make sure the battery is not sitting on bare earth or concrete while being charged. A block of wood or a small stack of newspapers will prevent the battery from losing internal heat while charging.

When replacing a battery, it is important that the replacement have an Cold Cranking Amps (CCA) output rating equal to or when greater than original equipment. See Section 3 for details on the battery.

✻✻CAUTION

If you get battery acid in your eyes or on your skin, rinse it off immediately with lots of water. Consult a doctor immediately if it gets in your eyes. The hydrogen gases formed inside the battery cells are highly explosive. Never check the level of the electrolyte in the presence of flame or when smoking. Never charge a battery in an unventilated area. Never smoke around a battery being charged.

JUMP STARTING A DEAD BATTERY

➧ See Figure 37

Whenever a vehicle is jump started, precautions must be followed in order to prevent the possibility of personal injury. Remember that batteries contain a small amount of explosive hydrogen gas which is a by-product of battery charging. Sparks should always be avoided when working around batteries, especially when attaching jumper cables. To minimize the possibility of accidental sparks, follow the procedure carefully.

✲✲CAUTION

NEVER hook the batteries up in a series circuit or the entire electrical system will go up in smoke, especially the starter!

Cars equipped with a diesel engine may utilize two 12 volt batteries. If so, the batteries are connected in a parallel circuit (positive terminal to positive terminal, negative terminal to negative terminal). Hooking the batteries up in parallel circuit increases battery cranking power without increasing total battery voltage output. Output remains at 12 volts. On the other hand, hooking two 12 volt batteries up in a series circuit (positive terminal to negative terminal, positive terminal to negative terminal) increases total battery output to 24 volts (12 volts plus 12 volts).

Jump Starting Precautions

- Be sure that both batteries are of the same voltage. Vehicles covered by this manual and most vehicles on the road today utilize a 12 volt charging system.
- Be sure that both batteries are of the same polarity (have the same terminal, in most cases NEGATIVE grounded).
- Be sure that the vehicles are not touching or a short could occur.
- On serviceable batteries, be sure the vent cap holes are not obstructed.
- Do not smoke or allow sparks anywhere near the batteries.
- In cold weather, make sure the battery electrolyte is not frozen. This can occur more readily in a battery that has been in a state of discharge.
- Do not allow electrolyte to contact your skin or clothing.

Jump Starting Procedure

1. Make sure that the voltages of the 2 batteries are the same. Most batteries and charging systems are of the 12 volt variety.
2. Pull the jumping vehicle (with the good battery) into a position so the jumper cables can reach the dead battery and that vehicle's engine. Make sure that the vehicles do NOT touch.
3. Place the transmissions of both vehicles in **NEUTRAL** or **PARK**, as applicable, then firmly set their parking brakes.

➡If necessary for safety reasons, the hazard lights on both vehicles may be operated throughout the entire procedure without significantly increasing the difficulty of jumping the dead battery.

4. Turn all lights and accessories off on both vehicles. Make sure the ignition switches on both vehicles are turned to the **OFF** position.
5. Cover the battery cell caps with a rag, but do not cover the terminals.
6. Make sure the terminals on both batteries are clean and free of corrosion or proper electrical connection will be impeded. If necessary, clean the battery terminals before proceeding.
7. Identify the positive (+) and negative (-) terminals on both battery posts.
8. Connect the first jumper cable to the positive (+) terminal of the dead battery, then connect the other end of that cable to the positive (+) terminal of the booster (good) battery.
9. Connect one end of the other jumper cable to the negative (-) terminal on the booster battery and the other cable clamp to an engine bolt head, alternator bracket or other solid, metallic point on the engine with the dead battery. Try to pick a ground on the engine that is positioned away from the battery in order to minimize the possibility of the 2 clamps touch-

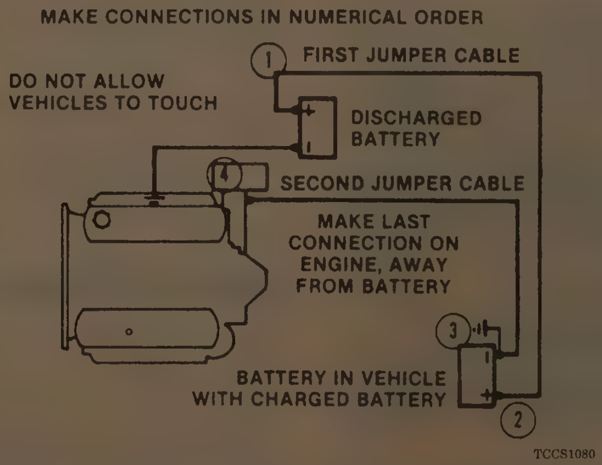
MAKE CONNECTIONS IN NUMERICAL ORDER
1
FIRST JUMPER CABLE
DO NOT ALLOW VEHICLES TO TOUCH
+
DISCHARGED BATTERY
4
SECOND JUMPER CABLE
MAKE LAST CONNECTION ON ENGINE, AWAY FROM BATTERY
3
BATTERY IN VEHICLE WITH CHARGED BATTERY
+
2
TCCS1080

Fig. 37 Connect the jumper cables to the batteries and engine in the order shown

ing should one loosen during the procedure. DO NOT connect this clamp to the negative (-) terminal of the bad battery.

✱✱CAUTION

Be very careful to keep the jumper cables away from moving parts (cooling fan, belts, etc.) on both engines.

10. Check to make sure that the cables are routed away from any moving parts, then start the donor vehicle's engine. Run the engine at moderate speed for several minutes to allow the dead battery a chance to receive some initial charge.
11. With the donor vehicle's engine still running slightly above idle, try to start the vehicle with the dead battery. Crank the engine for no more than 10 seconds at a time and let the starter cool for at least 20 seconds between tries. If the vehicle does not start within 3 tries, it is likely that something else is also wrong or that the battery needs additional time to charge.
12. Once the vehicle is started, allow it to run at idle for a few seconds to make sure that it is operating properly operating.
13. Turn on the headlights, heater blower and, if equipped, the rear defroster of both vehicles in order to reduce the severity of voltage spikes and subsequent risk of damage to the vehicles' electrical systems when the cables are disconnected. This step is especially important to late model vehicles equipped with computer control modules.
14. Carefully disconnect the cables in the reverse order of connection. Start with the negative cable that is attached to the engine ground, then the negative cable on the donor battery. Disconnect the positive cable from the donor battery and finally, disconnect the positive cable from the formerly dead battery. Be careful when disconnecting the cables from the positive terminals not to allow the alligator clips to touch any metal on either vehicle or a short and sparks will occur.

Belts

INSPECTION

➧ See Figure 38

Accessory drive-belt tension is checked every 6000 to 7500 miles (9662-12,077 km). Loose belts can cause poor engine cooling and diminish alternator or power steering pump output. A belt that is too tight places a severe strain on the water pump, alternator, and power steering pump bearings. A belt will loosen with age and wear. A belt loose enough to slip on its pulleys will make a loud, squealing noise. The noise is usually heard under acceleration or during a sharp turn.

To check drive belt tension, push lightly on the belt midway between the pulleys. Correct deflection of the belt is $^{3}/_{16}$-$^{5}/_{16}$ in. (5-10mm). Longer or shorter belts may have slightly more or less deflection. Remember that too tight is as damaging as too loose. Any belt that is glazed, frayed, or stretched so that it cannot be tightened sufficiently must be replaced.

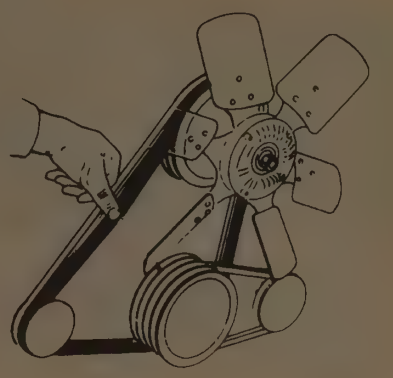

Fig. 38 Check the belt tension at the midway point as shown

ADJUSTING

➧ See Figures 39 and 40

Incorrect belt tension is usually corrected by moving the driven accessory (alternator, power steering pump, etc.) away from or toward the driving pulley. Loosen the mounting and adjusting bolts on the accessory and move it to loosen or tighten the belt. Once the belt tension is correct, retighten the mounting bolts and recheck the tension. Never position a metal prybar on the rear end of the alternator housing or against the power steering pump reservoir; they can be easily deformed.

Some models equipped with air conditioning are equipped with a two-part pulley that is split in halves (like two saucers back-to-back). Instead of a tensioner that removes slack, there are very thin spacer shims of various thicknesses in between the pulley halves. Removing a shim effectively tightens the belt by narrowing the pulley, thereby forcing the belt to ride higher and farther from the center. Adding shims effectively loosens the belt by widening the pulley and allowing the belt to ride in the pulley closer to its center (see photographs). When replacing a belt with a new one, begin with the same number of spacers as originally used, then tighten the pulley fasteners (often six in a hex pattern). Check the tension of the belt, and if necessary, adjust by removing shims until the correct tension is achieved. Belt tension should be within the specifications of an ordinary drive belt, as described in the previous paragraph. The belt should be correctly tensioned before installing the rest of the components necessary to complete the job.

REMOVAL & INSTALLATION

If a belt must be replaced, the driven unit must be loosened and moved to its extreme loosest position, generally by moving it toward the center of the motor. After removing the old belt, check the pulleys for dirt or built-up material which could affect belt contact. Carefully install the new belt, remembering that it is new and unused and it may appear to be just a little too small to fit over the pulley flanges. Fit the belt over the largest pulley (usually the crankshaft pulley at the bottom center of the

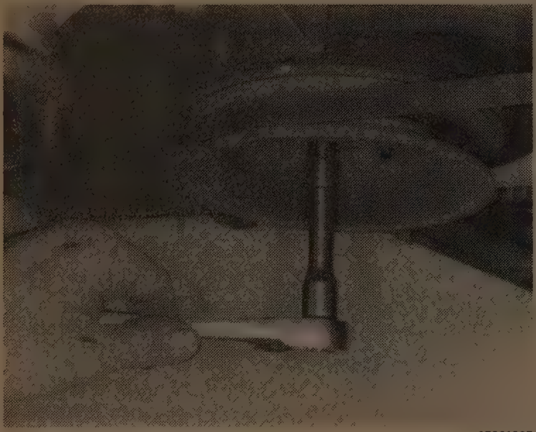

Fig. 39 Tighten the shim-adjustable pulley wheel, then check the belt tension

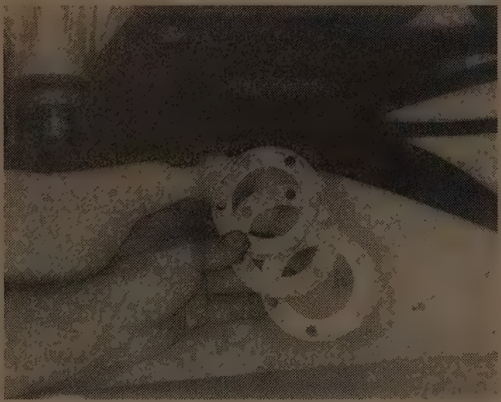

Fig. 40 Add or subtract adjustable shims to alter the belt tension (once the pulley is clamped down by tightening its fasteners)

motor) first, then work on the smaller one(s). Gentle pressure in the direction of rotation is helpful. Some belts run around a third or idler pulley, which acts as an additional pivot in the belt's path. It may be possible to loosen the idler pulley as well as the main component, making your job much easier. Depending on which belt(s) you are changing, it may be necessary to loosen or remove other interfering belts to get at the one(s) you want.

When buying replacement belts, remember that the fit is critical according to the length of the belt (circumference), the width of the belt, the depth of the belt and the angle or profile of the V shape. The belt shape should exactly match the shape of the pulley; belts that are not an exact match can cause noise, slippage and premature failure.

After the new belt is installed, draw tension on it by moving the driven unit away from the motor and tighten its mounting bolts. This is sometimes a three or four-handed job; you may find an assistant helpful. Make sure that all the bolts you loosened get retightened and that any other loosened belts also have the correct tension. A new belt can be expected to stretch a bit after installation, so be prepared to re-adjust your new belt, if needed, within the first 100 miles (161 km) of use.

Timing Belts

INSPECTION

WARNING

Severe engine damage may occur if the timing belt breaks. Some Volvo engines are of an "interference" design, on which a broken timing belt will allow the valves to contact the pistons.

Volvo advises that a new timing belt be inspected and adjusted, if necessary, at 600-1200 miles (966-1932 km). The timing belt should be replaced at 50,000 miles (80,000 km). Replacing the timing belt before its recommended interval is a wise choice. It is far less expensive to replace the belt than to repair the engine damage which can result from the belt breaking.

Inspect the belt for cracks, missing teeth and wear on any of the surfaces. Inspect the sprockets for grease and other deposits. If any of these conditions exist, the belt should be replaced. Please refer to Section 3 for procedures on timing belt removal and installation.

Hoses

Hoses should be inspected at least once a month for cracks, swelling and softness. When inspecting hoses, be sure to check the bottom radiator hose, as this one can be easily overlooked. Since the hoses are generally the weakest link in the cooling system, always inspect them before going on a long trip and at the onset of cold or hot weather. The hoses to and from the radiator are the most visible, but there are also other water hoses under the hood, notably the heater hoses running to the firewall. Check these hoses at the same time you check the radiator hoses.

REMOVAL & INSTALLATION

➧ See Figure 41

Replacing hoses requires draining the cooling system. This potentially messy job involves working under the car and handling antifreeze, a slippery, smelly, stain-making chemical. Have a large drain pan or bucket available along with healthy supply of rags. Be prepared to deal with fluid spills immediately. See the previous list of Do's and Don'ts for other hints.

1. Drain the cooling system. This is always done with the engine cold. Attempting to drain hot coolant is very foolish; you can be badly scalded.
    a. Remove the radiator cap.
    b. Position the drain pan under the point where the lower radiator hose to the radiator. Loosen the clamp on the hose and slide it back so it is out of the way.
    c. Gently break the grip of the hose on its fitting by twisting or prying with a suitable tool. Do not exert too much

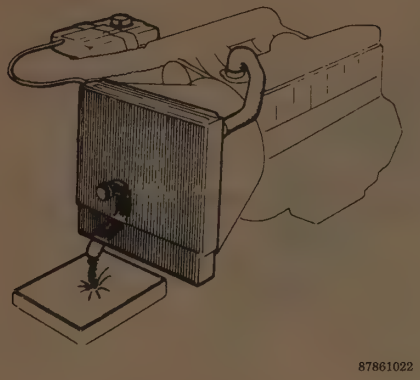

Fig. 41 Remove the lower hose to drain the radiator

force or you will damage the radiator fitting. As the hose loosens, you can expect a gush of fluid to come out — be ready.

d. Remove the hose end from the radiator and direct the hose into the drain pan. You now have fluid running from both the hose and the radiator. When the system stops draining, proceed with removal of the hose.

✻✻CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Loosen the hose clamps with a screwdriver and slide the clamps either off the hose altogether or in toward the center.
3. Break the grip of the hose at both ends by prying it free with a suitable tool or by twisting it with your hand.
4. Remove the hose.
5. Clean the hose fitting of any material or other deposits.

To install:

6. Install a new, or if reusable, the old hose. A small amount of soapy water on the inside of the hose end will ease installation.

➡Radiator hoses should be routed with no kinks and, when installed, should be in the same position as the original. If other than specified hose is used, make sure it does not rub against either the engine or the frame while the engine is running, as this may wear a hole in the hose. Contact points may be insulated with a piece of sponge or foam; plastic wire ties are particularly handy for this job.

7. Slide the hose clamps back into position and retighten. When tightening the clamps, tighten them enough to seal in the coolant but not so much that the clamp cuts into the hose or causes it internal damage. If a clamp shows signs of any damage (bent, too loose, hard to tighten, etc.) now is the time to replace it. A good rule of thumb is that a new hose is always worth new clamps.
8. Reinstall the lower radiator hose and secure its clamp.
9. Fill the system with coolant. Volvo strongly recommends the coolant mixture be a 50-50 mix of antifreeze and water. This mixture gives best combination of antifreeze and anti-boil characteristics for year-round driving.
10. Replace and tighten the radiator cap. Start the engine and check visually for leaks. Allow the engine to warm up fully and continue to check your work for signs of leakage. A very small leak may not be noticed until the system develops internal pressure. Leaks at hose ends are generally clamp related and can be cured by snugging the clamp. Larger leaks may require removing the hose again — to do this you MUST WAIT UNTIL THE ENGINE HAS COOLED DOWN, GENERALLY A PERIOD OF HOURS. NEVER UNCAP A HOT RADIATOR. After all leaks are cured, check the coolant level in the radiator (with the engine cold) and top up as necessary.

Air Conditioning System

➧ See Figure 42

✻✻CAUTION

The refrigerant used in A/C systems is an extremely cold substance. When exposed to air, it will instantly freeze any surface it comes in contact with, including your eyes. It is imperative to use eye and skin protection when working on A/C systems.

SAFETY PRECAUTIONS

➡R-12 refrigerant is a chlorofluorocarbon which, when released into the atmosphere, contributes to the depletion of the ozone layer. Ozone filters out harmful radiation from the sun. Consult the laws in your area before servicing the air conditioning system. In some states it is illegal to perform repairs involving refrigerant unless the work is done by a certified technician. It is also likely that you will not be able to purchase R-12 without proof that you are properly trained and certified to work on A/C systems.

- The refrigerant used in A/C systems is an extremely cold substance. When exposed to air, it will instantly freeze any surface it comes in contact with, including your eyes.
- Although normally non-toxic, refrigerant gas becomes highly poisonous in the presence of an open flame. One good whiff of the vapor formed by refrigerant can be fatal. Keep all forms of fire (including cigarettes) well clear of the air conditioning system.
- It has been established that the chemicals in R-12 contribute to the damage occurring in the upper atmosphere. This refrigerant must be discharged using the proper recovery/recycling equipment.
- Only use recovery/recycling systems which are U.L-listed and are certified to meet SAE requirements for the type of refrigerant system to be serviced. Follow the instructions pro-

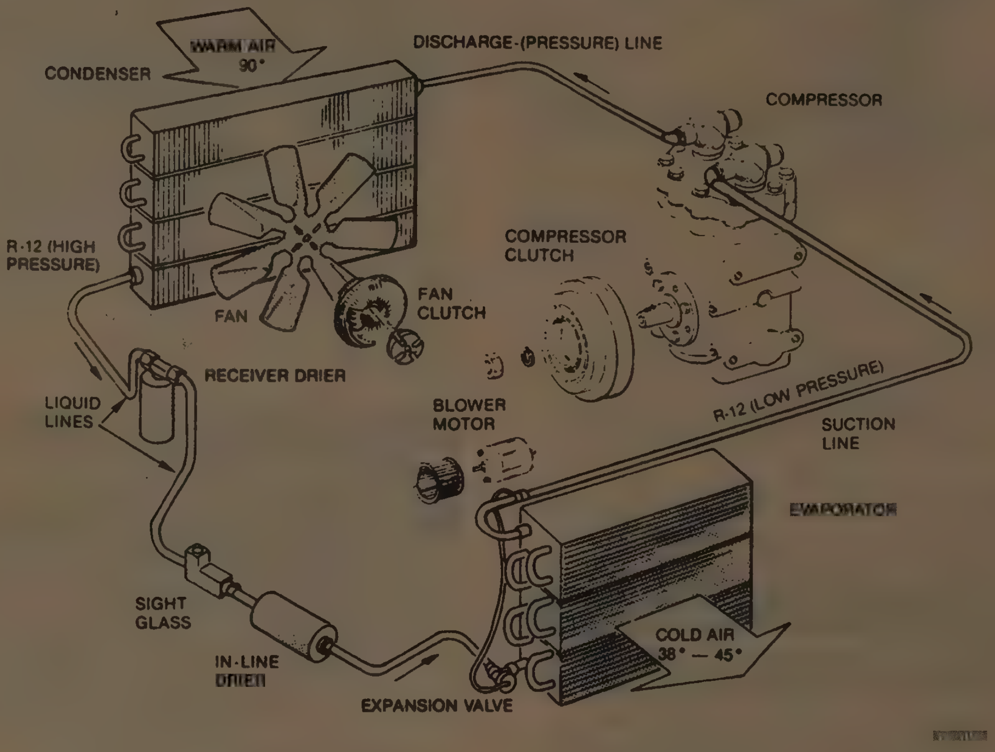
WARM AIR
90°
CONDENSER
DISCHARGE-(PRESSURE) LINE
COMPRESSOR
R-12 (HIGH PRESSURE)
COMPRESSOR CLUTCH
FAN
FAN CLUTCH
RECEIVER DRIER
LIQUID LINES
BLOWER MOTOR
R-12 (LOW PRESSURE)
SUCTION LINE
EVAPORATOR
SIGHT GLASS
COLD AIR
38° — 45°
IN-LINE DRIER
EXPANSION VALVE

Fig. 42 A common air conditioning system

vided with the equipment carefully when discharging the system.

- Servicing (recovery, evacuation and charging) of the A/C system should be left to a professional, certified mechanic with the proper equipment and related training.

SYSTEM INSPECTION

➧ See Figure 43

A lot of A/C problems can be avoided by simply running the air conditioner at least once a week, regardless of the season. Let the system run for at least five minutes a week (even in the winter), and you'll keep the internal parts lubricated and prevent the hoses from hardening.

Refrigerant leaks show up as oily areas on the components because the compressor oil is transported around the entire system with the refrigerant. Look for oily spots on all the hoses and lines, and especially on the hose and tubing connections. If there are oily deposits, the system may have a leak. A small area of oil on the front of the compressor is normal and no cause for alarm.

The compressor drive belt should be checked frequently for proper tension and condition. Refer to the portion of this section on "Belts".

Periodically inspect the front of the condenser for bent fins or foreign material (dirt, bugs, leaves, etc.). If any cooling fins are bent, straighten them carefully with needle nosed pliers. You can remove any debris with a stiff bristle brush or hose.

REFRIGERANT LEVEL CHECK

➧ See Figure 44

The first order of business when checking the refrigerant level is to find the sight glass. It is located in the head of the receiver/drier. Once you've found it, wipe it clean and proceed as follows:

1. With the engine and the air conditioning system running, look for the flow of refrigerant in the sight glass. If the air conditioner is working properly, you'll be able to see a continu-

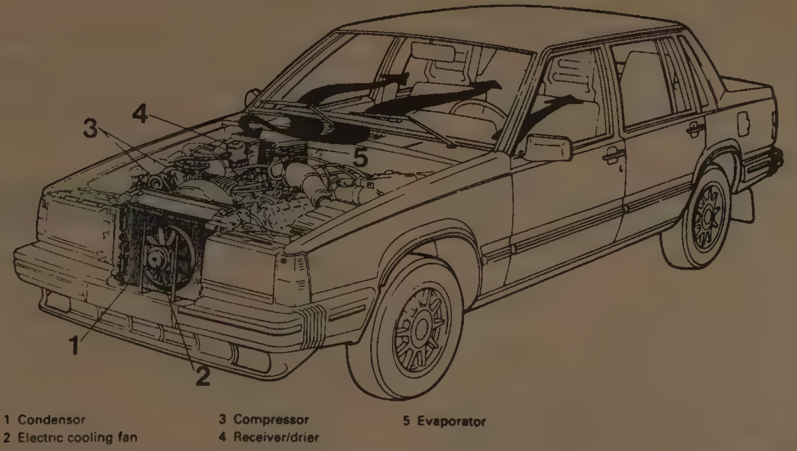

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Fig. 43 Common locations of air conditioning components

ous flow of clear refrigerant through the sight glass, with perhaps an occasional bubble at very high temperatures.

2. Cycle the air conditioner on and off to make sure what you are seeing is clear refrigerant. Since the refrigerant is clear, it is possible to mistake a completely discharged system for one that is fully charged. Turn the system off and watch the sight glass. If there is refrigerant in the system, you'll see bubbles during the off cycle. If you observe no bubbles when the system is running, and the air flowing from the unit in the car is cold, everything is OK.

3. If you observe bubbles in the sight glass while the system is operating, the system may be low on refrigerant. It should be noted that some late model cars are equipped with an automatic temperature switch which will turn the system off even though the dash controls are still on. If you are seeing bubbles in the sight glass, open the car doors for a few minutes. The system should switch back on and the bubbles will disappear. The system switching on and off is accompanied by a loud click as the compressor engages and disengages.

4. Oil streaks in the sight glass are an indication of trouble. Most of the time, if you see oil in the sight glass, it will appear as a series of streaks, although occasionally it may be a solid stream of oil. In either case, it means that part of the charge has been lost. This is almost always accompanied by a reduction in cold air output within the car.

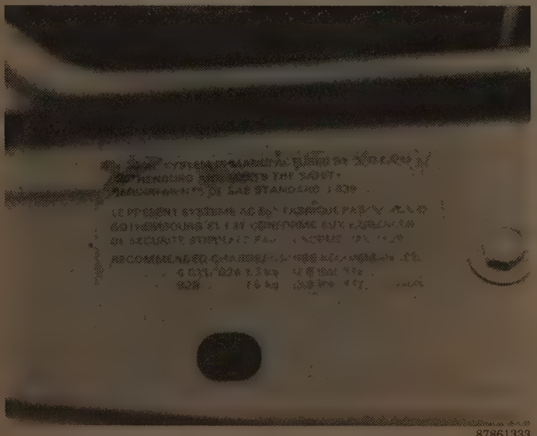

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Fig. 44 This label provides needed information for servicing the A/C system — 240 series model shown

OPERATION

Once the air conditioning system is fully charged and free of leaks, it is ready to operate on demand. When turned on, the compressor discharges high temperature and high pressure refrigerant. This refrigerant gas contains heat transferred from inside the car plus the heat developed by the compressor on the discharge stroke.

This gaseous refrigerant flows into the condenser. Because of the airflow through the condenser, heat is removed from the gas. Now cooled, the gas condenses into a liquid and flows into the suction accumulator/drier. The suction accumulator/drier stores the liquid refrigerant and filters out small amounts of moisture which may be present.

Flowing from the receiver, the liquid refrigerant passes through an expansion valve which changes it into a low temperature, low pressure mixture of gas and liquid. This cold and foggy refrigerant flows to the evaporator/blower unit.

Once in the evaporator core, (inside the cabin of the vehicle) the refrigerant is exposed to the warmer air being moved by the blower fan. The refrigerant changes to a gas within the evaporator and absorbs heat from the air being circulated by the fan. After being fully vaporized within the evaporator, the heated refrigerant gas is drawn out of the evaporator to the compressor where the cycle continues.

The efficiency of any air conditioning system is controlled not only by the system itself but by outside factors such as air temperature, humidity, forward speed of the car and amount of sunlight entering the car.

CHECKING FOR A/C OIL LEAKS

Refrigerant leaks show up only as oily areas on the various components because the compressor oil is transported around the entire system along with the refrigerant. Look for oily spots on all the hoses and lines (especially on the hose and tube connections). If there are oily deposits, the system may have a leak, and you should have it checked by a qualified mechanic.

CHECKING THE A/C COMPRESSOR BELT

The compressor drive belt should be checked frequently for tension and condition. Refer to the earlier portion of this section regarding belt inspection and adjustment.

KEEP THE A/C CONDENSER CLEAR

The condenser is mounted in front of the radiator (and is often mistaken for the radiator). It serves to remove heat from the air conditioning system and to cool the refrigerant. Proper air flow through the condenser is critical to the operation of the system.

Periodically inspect the front of the condenser for bent fins or foreign material (dirt, bugs, leaves, etc.). If any cooling fins are bent, straighten them carefully with needle nose pliers. You can remove any debris with a stiff bristle brush or hose.

GAUGE SETS

➧ See Figure 45

Generally described, this tool is a set of two gauges, a manifold and three hoses. By connecting the proper hoses to the car's system, the gauges can be used to "see" the air conditioning system at work. Do not use the gauge set as a means for discharging the system.

DISCHARGING, EVACUATING AND CHARGING

If anything indicates a low charge or loss of refrigerant, the system must be discharged (emptied) and refilled to the proper level. It is not acceptable to simply add refrigerant to a partially discharged system.

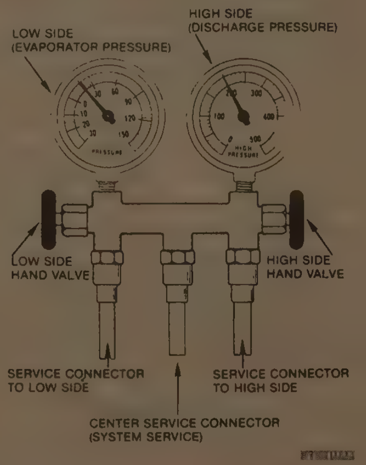

Fig. 45 Air conditioning manifold gauge set

Discharging, evacuating and charging the air conditioning system must be performed by a properly trained and certified mechanic in a facility equipped with refrigerant recovery/recycling equipment that meets SAE standards for the type of system to be serviced.

Windshield Wipers

Intense heat and ultra-violet rays from the sun, snow, ice and frost, road oils, acid rain, and industrial pollution all combine quickly to deteriorate the rubber wiper refills. One pass on a frosty windshield can reduce a new set of refills to an unusable condition. The refills should be replaced about twice a year or whenever they begin to streak or chatter on wet glass.

Blade life can be prolonged by frequent cleanings of the glass with a rag and a commercial glass cleaner. The use of an ammonia based cleaner will ease the removal of built-up road oils and grease from the glass. Ammonia based cleaners are harmful, however, to painted surfaces. Be careful when applying such cleaners and don't fill the washer reservoir with an ammonia based solvent; when used in that manner, it will run onto the painted bodywork.

WIPER REFILL REPLACEMENT

➧ See Figures 46, 47 and 48

If the wipers are not cleaning the windshield properly, only the refill has to be replaced. The blade and arm usually require replacement only in the event of damage. It is not necessary (except on new Tridon® refills) to remove the arm or the blade to replace the refill (rubber part), though you may have to position the arm higher on the glass. You can do this by turning the ignition switch on and operating the wipers. When they are positioned where they are accessible, turn the ignition switch off.

There are several types of refills and your vehicle could have any kind, since aftermarket blades and arms may not use exactly the same type refill as the original equipment.

Most Anco® styles use a release button that is pushed down to allow the refill to slide out of the yoke jaws. The new refill slides in and locks in place. Some Anco® refills are removed by noting where the metal backing strips or the refill is wider. Insert a small screwdriver blade between the frame and metal backing strip. Press down to release the refill from the retaining tab.

The Trico® style is unlocked at one end by squeezing two metal tabs, and the refill is slid out of the frame jaws. When the new refill is installed, the tabs will click into place, locking the refill.

The polycarbonate type is held in place by a locking lever that is pushed downward (out of the groove in the arm) to free the refill. When the new refill is installed, it will lock in place automatically.

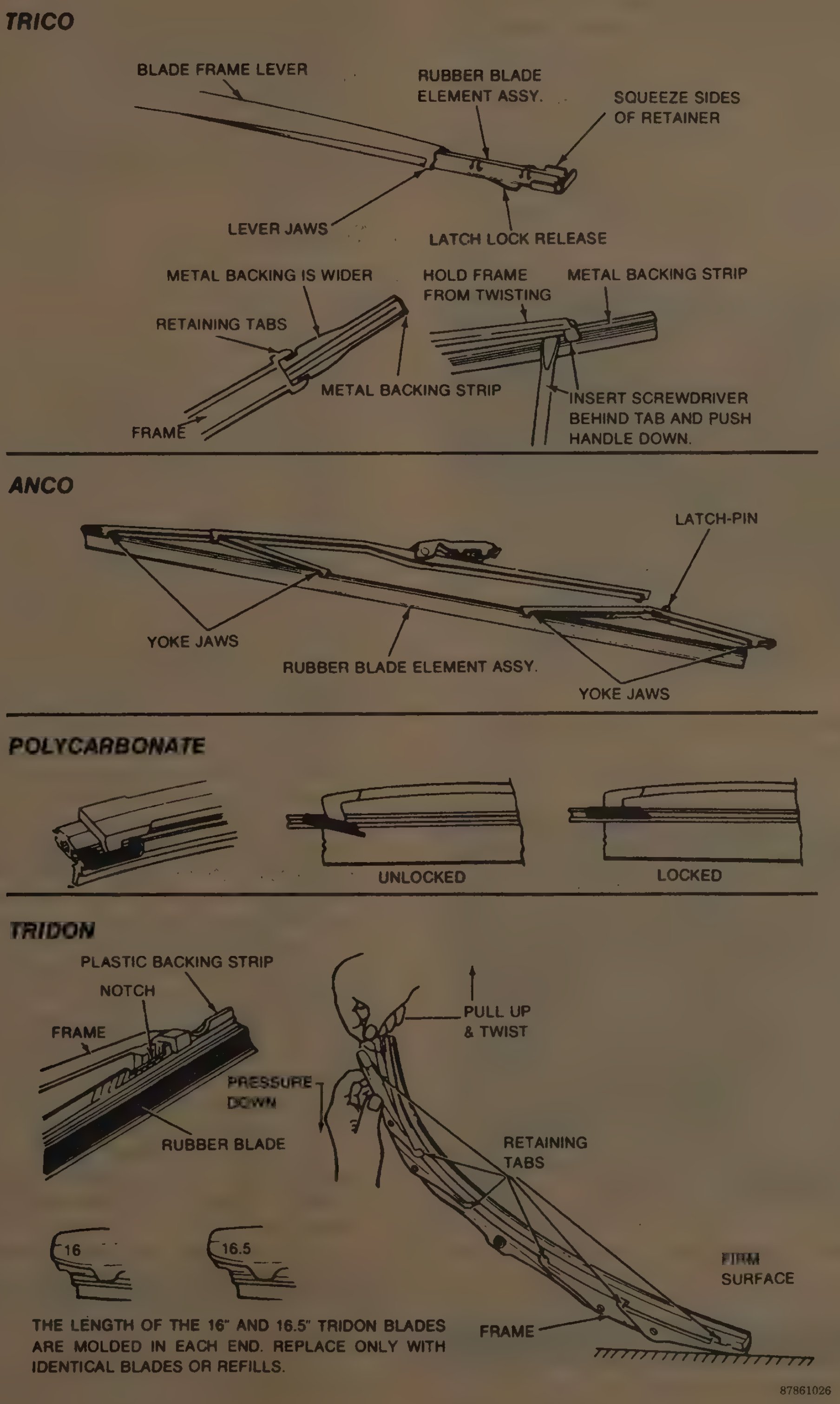
TRICO
BLADE FRAME LEVER
RUBBER BLADE ELEMENT ASSY.
SQUEEZE SIDES OF RETAINER
LEVER JAWS
LATCH LOCK RELEASE
METAL BACKING IS WIDER
HOLD FRAME FROM TWISTING
METAL BACKING STRIP
RETAINING TABS
METAL BACKING STRIP
FRAME
INSERT SCREWDRIVER BEHIND TAB AND PUSH HANDLE DOWN.
ANCO
LATCH-PIN
YOKE JAWS
RUBBER BLADE ELEMENT ASSY.
YOKE JAWS
POLYCARBONATE
UNLOCKED
LOCKED
TRIDON
PLASTIC BACKING STRIP
NOTCH
FRAME
PULL UP & TWIST
PRESSURE DOWN
RUBBER BLADE
RETAINING TABS
16
16.5
FIRM SURFACE
THE LENGTH OF THE 16" AND 16.5" TRIDON BLADES ARE MOLDED IN EACH END. REPLACE ONLY WITH IDENTICAL BLADES OR REFILLS.
FRAME
87861026

Fig. 46 Replacement procedures for common windshield wiper blade assemblies

The Tridon® refill has a plastic backing strip with a notch about an inch from the end. Hold the blade (frame) on a hard surface so that the frame is tightly bowed. Grip the tip of the backing strip and pull up while twisting counterclockwise. The backing strip will snap out of the retaining tab. Do this for the remaining tabs until the refill is free of the arm. The length of these refills is molded into the end and they should be replaced with identical types.

No matter which type of refill you use, be sure that all of the frame claws engage the refill. Before operating the wipers, be sure that no part of the metal frame is contacting the windshield.

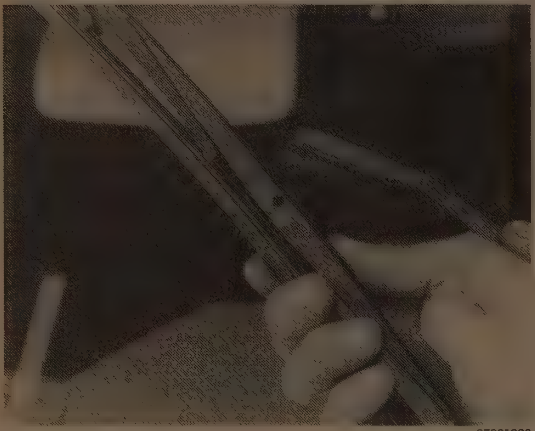
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Fig. 47 Remove the windshield wiper blade from the arm

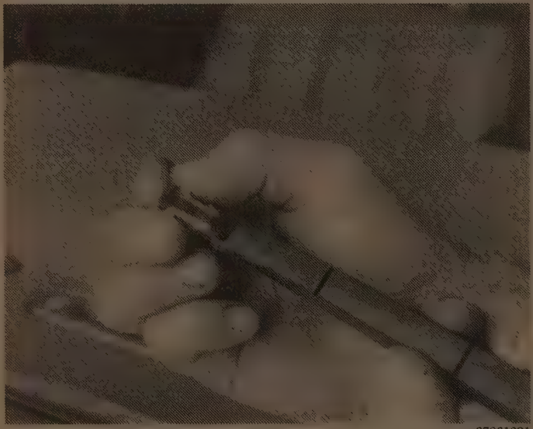
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Fig. 48 Unlock the insert from the blade assembly and remove

Tires and Wheels

Common sense and good driving habits will afford maximum tire life. Fast starts and stops, and hard cornering are hard on tires and will shorten their useful life span. If you start at normal speeds, allow yourself sufficient time to stop, and take corners at a reasonable speed, the life of your tires will increase greatly. Also make sure that you don't overload your vehicle or run with incorrect pressure in the tires. Both of these practices increase tread wear.

Inspect your tires frequently. Be especially careful to watch for bubbles in the tread or side wall, deep cuts, or underinflation. Replace any tires with bubbles. If the cuts are so deep that they penetrate to the cords, discard the tire. Any cut in the sidewall of a radial tire renders it unsafe. Also look for uneven tread wear patterns that indicate that the front end is out of alignment or that the tires are out of balance.

TIRE DESIGN

➧ See Figure 49

Conventional bias ply tires are constructed so that the cords run bead-to-bead at an angle. This type of construction gives rigidity to both tread and sidewall.

Bias-belted tires are an evolutionary improvement over bias ply tires. Belts are laid at alternating angles from bead-to-bead, and also at a 90° angle to the bead, as in the radial tire. Tread life is improved considerably over the conventional bias ply tire.

The radial tire differs in construction. Instead of the carcass plies running at an angle of 90° to each other, they run at a 90° angle to the bead. This gives the tread and sidewall a great deal of flexibility and accounts for the characteristic bulge surrounding the contact patch associated with radial tires.

Snow tires should not be operated at sustained speeds over 70 mph (113 kph), unless they are specially designed as "performance snow tires" and carry a manufacturer's speed rating.

When buying new tires, you should keep the following points in mind, especially if you are switching to larger tires or a different profile series (for example: 50, 60, 65, 70, 78):

- All four tires should be of the same construction type. Radial, bias,or bias-belted tires should not be mixed. Radial tires are highly recommended for their excellent handling and fuel mileage characteristics. Most new vehicles from 1980 on were delivered with radial tires as standard equipment.
- The wheels must be the correct width for the tire. Tire dealers have charts of tire and wheel compatibility. A mismatch can cause sloppy handling and rapid tread wear. The tread width should match the rim width (inside bead to inside bead) within an inch. For radial tires the rim width should be 80% or less of the tire (not tread) width. The accompanying illustration gives an example of a tire size designation.
- The height (mounted diameter) of the new tires can change speedometer accuracy, engine speed per given road speed, fuel mileage, acceleration, and ground clearance. Tire manufacturers furnish full measurement specifications to their dealers.
- There shouldn't be any body interference when the car is loaded, on bumps or in turning through maximum range.

TIRE INFLATION

➧ See Figure 50

Tire inflation is generally the most ignored item of auto maintenance, a potentially costly and hazardous oversight. When underinflated, tires wear unevenly requiring early replacement.

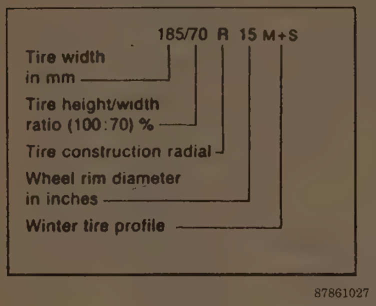


Fig. 49 Tire designation markings and their meanings

Also the contact patch of a poorly inflated tire is less stable and therefore provides less grip. An underinflated tire is more prone to bottoming-out over bumps and potholes leading to bent wheels, flats, or both. Increased load (such as when carrying passengers, cargo or both) will exacerbate any of the above problems. Studies have shown gasoline mileage can drop as much as 0.8% for every 1 psi (7 kPa) of underinflation.

Two items should be a permanent fixture in every glove compartment: a tire pressure gauge and a tread depth gauge. Check the tire pressure, including the spare, regularly with a pocket type gauge or preferably, a dial gauge. Kicking the tires won't tell you a thing, and the gauge on a service station air hose is notoriously inaccurate.

➡Avoid dropping a dial gauge or exposing it to sudden shocks, as this may cause it to go out of calibration.

A plate located on the left door will tell the proper pressure for the tires. Ideally, inflation pressure should be checked before driving when the tires are cold. When driven on, tires flex, create friction, and the air inside them expands increasing pressure.) Every 10°F (5.6°C) rise or drop in temperature means a difference of 1 psi (7 kPa), which explains why the tire seems to lose air on a cold night or during the fall and winter seasons. When it is impossible to check the tires cold, allow for pressure build-up due to heat. If the hot pressure exceeds the cold pressure by more than 15 psi (104 kPa), reduce vehicle speed, load or both. This is a sure sign that excess internal heat is being created in the tire, and the temperature could continue to rise. If the heat approaches the temperature at which the tire was cured during manufacture, the tread could separate from the body.

✲✲WARNING

Never attempt to counteract excessive pressure build-up by bleeding off air pressure (letting some air out). This will produce the opposite of the desired effect by allowing more tire flex and friction, further raising the tire temperature.

➡Before starting a long trip with lots of luggage, you can add about 2-4 psi (14-28 kPa) to the tires to make them run cooler but never exceed the maximum inflation pressure on the side of the tire.

TREAD DEPTH

▶ See Figures 51, 52 and 53

All tires made since 1968 have eight built-in tread wear indicator bars. They show up as ½ in. (13mm) wide smooth bands across the tire when 1/16 in. (1.6mm) of tread remains. The appearance of tread wear indicators means that the tires should be replaced. In fact, many states have laws prohibiting the use of tires with less than 1/16 in. (1.6mm) tread.

You can check your own tread depth with an inexpensive gauge or by using a Lincoln head penny. Slip the Lincoln penny into several tread grooves. If you can see the top of Lincoln's head in two adjacent grooves, the tires have less than 1/16 in. (1.6mm) tread left and should be replaced. You can measure snow tires in the same manner by using the "tails" side of the Lincoln penny.

A tread depth gauge will allow you to more accurately monitor the wear of your tires over time and you will be able to check that the tire is wearing evenly across the tread width.

TIRE ROTATION

▶ See Figure 54

➡If studded snow tires are used, be sure to mark the wheel position or direction of rotation before removal, since such tires are unidirectional.

So that the tires wear more uniformly, it is recommended that the tires be rotated every 6000 miles (9662 km). This can be done when all four tires are of the same size and load rating capacity. Any abnormal wear should be investigated and the cause corrected.

✲✲WARNING

Avoid overtightening the lug nuts, or the brake disc or drum may become permanently distorted. Alloy wheels can be cracked by overtightening. Generally, nut torque should not exceed 60 ft. lbs. (81 Nm). Always tighten the nuts in a crisscross pattern.

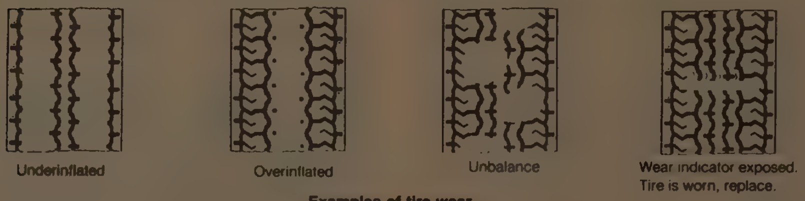
TIRE STORAGE

Store the tires at proper inflation pressure if they are mounted on wheels. All tires should be kept in a cool, dry place. If they are stored in the garage or basement, do not let them stand on a concrete floor, set them on strips of wood.

Tire Size Comparison Chart

"Letter" sizes			Inch Sizes	Metric-inch Sizes		
"60 Series"	"70 Series"	"78 Series"	1965–77	"60 Series"	"70 Series"	"80 Series"
			5.50-12, 5.60-12	165/60-12	165/70-12	155-12
		Y78-12	6.00-12			
		W78-13	5.20-13	165/60-13	145/70-13	135-13
		Y78-13	5.60-13	175/60-13	155/70-13	145-13
			6.15-13	185/60-13	165/70-13	155-13, P155/80-13
A60-13	A70-13	A78-13	6.40-13	195/60-13	175/70-13	165-13
B60-13	B70-13	B78-13	6.70-13	205/60-13	185/70-13	175-13
			6.90-13			
C60-13	C70-13	C78-13	7.00-13	215/60-13	195/70-13	185-13
D60-13	D70-13	D78-13	7.25-13			
E60-13	E70-13	E78-13	7.75-13			195-13
			5.20-14	165/60-14	145/70-14	135-14
			5.60-14	175/60-14	155/70-14	145-14
			5.90-14			
A60-14	A70-14	A78-14	6.15-14	185/60-14	165/70-14	155-14
	B70-14	B78-14	6.45-14	195/60-14	175/70-14	165-14
	C70-14	C78-14	6.95-14	205/60-14	185/70-14	175-14
D60-14	D70-14	D78-14				
E60-14	E70-14	E78-14	7.35-14	215/60-14	195/70-14	185-14
F60-14	F70-14	F78-14, F83-14	7.75-14	225/60-14	200/70-14	195-14
G60-14	G70-14	G77-14, G78-14	8.25-14	235/60-14	205/70-14	205-14
H60-14	H70-14	H78-14	8.55-14	245/60-14	215/70-14	215-14
J60-14	J70-14	J78-14	8.85-14	255/60-14	225/70-14	225-14
L60-14	L70-14		9.15-14	265/60-14	235/70-14	
	A70-15	A78-15	5.60-15	185/60-15	165/70-15	155-15
B60-15	B70-15	B78-15	6.35-15	195/60-15	175/70-15	165-15
C60-15	C70-15	C78-15	6.85-15	205/60-15	185/70-15	175-15
	D70-15	D78-15				
E60-15	E70-15	E78-15	7.35-15	215/60-15	195/70-15	185-15
F60-15	F70-15	F78-15	7.75-15	225/60-15	205/70-15	195-15
G60-15	G70-15	G78-15	8.15-15/8.25-15	235/60-15	215/70-15	205-15
H60-15	H70-15	H78-15	8.45-15/8.55-15	245/60-15	225/70-15	215-15
J60-15	J70-15	J78-15	8.85-15/8.90-15	255/60-15	235/70-15	225-15
	K70-15		9.00-15	265/60-15	245/70-15	230-15
L60-15	L70-15	L78-15, L84-15	9.15-15			235-15
	M70-15	M78-15				255-15
		N78-15				

Note: Every size tire is not listed and many size comparisons are approximate, based on load ratings. Wider tires than those supplied new with the vehicle, should always be checked for clearance.



Underinflated

Overinflated

Unbalance

Wear indicator exposed. Tire is worn, replace.

Examples of tire wear

Troubleshooting Basic Tire Problems

Problem	Cause	Solution
The car's front end vibrates at high speeds and the steering wheel shakes	• Wheels out of balance • Front end needs aligning	• Have wheels balanced • Have front end alignment checked
The car pulls to one side while cruising	• Unequal tire pressure (car will usually pull to the low side) • Mismatched tires • Front end needs aligning	• Check/adjust tire pressure • Be sure tires are of the same type and size • Have front end alignment checked
Abnormal, excessive or uneven tire wear	• Infrequent tire rotation • Improper tire pressure • Sudden stops/starts or high speed on curves	• Rotate tires more frequently to equalize wear • Check/adjust pressure • Correct driving habits
Tire squeals	• Improper tire pressure • Front end needs aligning	• Check/adjust tire pressure • Have front end alignment checked

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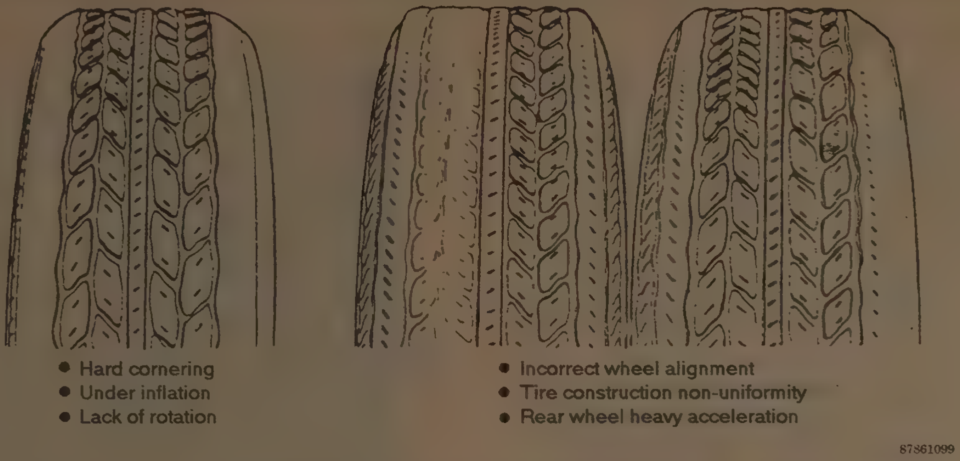
● Hard cornering
● Under inflation
● Lack of rotation
● Incorrect wheel alignment
● Tire construction non-uniformity
● Rear wheel heavy acceleration
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Fig. 50 Uneven tire wear can be caused by variables from tire/vehicle condition to driving style

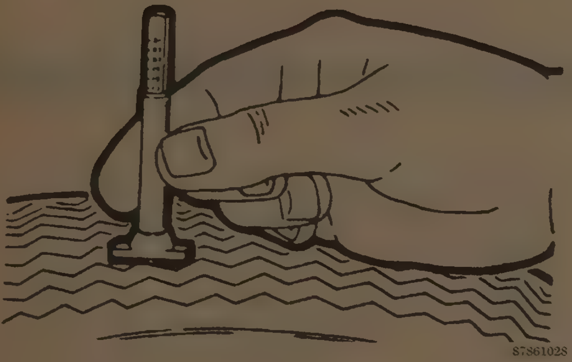

Fig. 51 A depth gauge is the most accurate way to determine tread depth

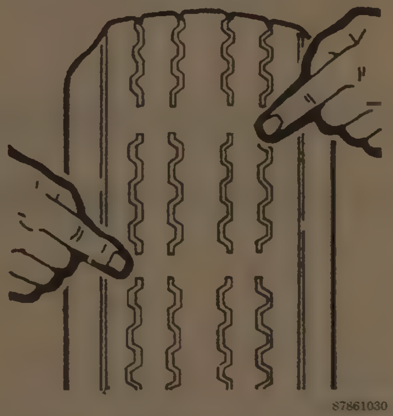

Fig. 53 This tire is ready for replacement since the built-in wear indicators are clearly visible, indicating minimal tread depth

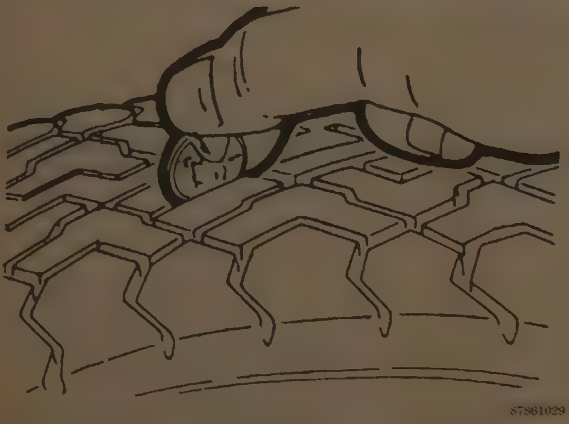

Fig. 52 A Lincoln head penny may also be used to determine tread depth

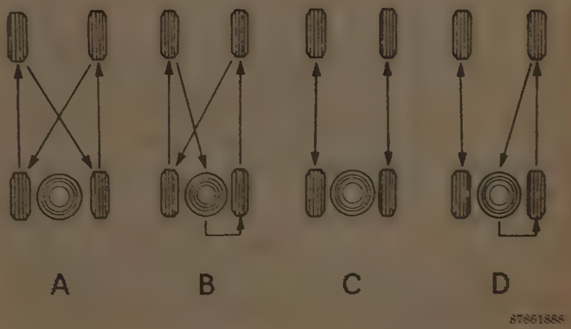
A
B
C
D
87861888

Fig. 54 Tire rotation patterns: "A" and "B" represent the usual pattern (in which cross-switching is recommended), while "C" or "D" is required for unidirectional tires. Including a full-size spare tire in the rotation will help extend the tread life of the tires

ALLOY WHEEL CARE

See Figure 55

Some Volvos are equipped with aluminum alloy wheels. These wheels are protected with a clear-coat finish when they are manufactured. This finish protects the alloy wheel from tarnishing or discoloring. When these wheels are handled, care should be taken to not scratch the coating. Also, when having replacement tires mounted, be sure to first inquire that the shop doing the work is equipped with a tire changing machine designed to not scratch alloy wheels. Traditional steel wheel tire changers may gouge the finish of alloy wheels.

Alloy wheels should be cleaned periodically (as-needed) to prevent potentially harmful road dirt and chemical buildup from eating away at the clear-coat finish. When cleaning alloy wheels, use only non-acid-based and non-abrasive cleaners. Cleaners containing harsh acids will etch the wheel surface and cause the coating to peel off. There are many good quality cleaners available that are specifically designed to cut the grime from alloy wheels without attacking the finish (soap and water will work, but brake dust stuck to the wheels is hard to remove). Always follow the manufacturer's directions given on the container when using a specific cleaner.

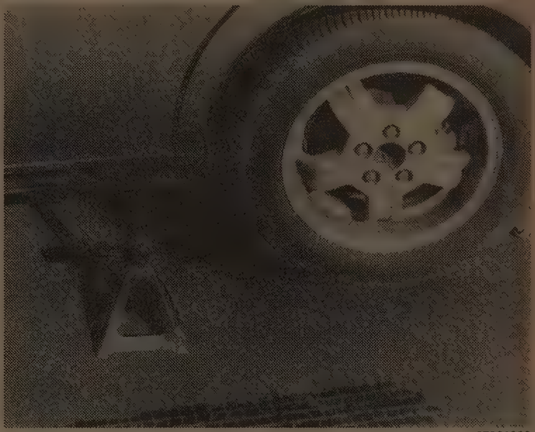
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Fig. 55 Take special care of the alloy wheels when cleaning and when having tires mounted

FLUIDS AND LUBRICANTS

Fuel Recommendations

GASOLINE ENGINES

All gasoline engine Volvos produced before the 1975 model year are designed to run on leaded (regular) gasoline. Many 1970-72 models with high compression ratios (9.3:1 to 10.5:1) require high octane fuel (97-100 RON). In recent years, it has become almost impossible to find gasoline with an octane rating this high, although some oil companies were making available a "Premium" fuel which approaches these levels. In these days of low compression, fuel efficient motors, pre-1975 cars may require a special lead-bearing additive which may be mixed with pump grade unleaded fuel.

1975 and later cars equipped with catalytic converters must use lead-free fuel or the catalyst will be rendered ineffective. These models carry an "Unleaded Gasoline Only" sticker in conspicuous view near the fuel filler cap. Other 1975 and later Volvos are designed to run on regular or low-lead fuel.

On most models, the octane rating needed to prevent engine knock is printed on a sticker inside the fuel filler cap lid. If no sticker is evident, consult your owner's manual. The most common octane requirement for Volvos is 91 RON, and this fuel is readily available.

Gasoline Octane Rating

Octane rating is based on the quantity of anti-knock compounds added to the gasoline and determines the speed at which the gas will burn; the lower the octane, the faster it burns. The higher the numerical octane rating, the slower the fuel will burn and the greater the percentage of compounds in the fuel to prevent spark ping (knock), detonation, and pre-ignition. As the temperature of the engine increases, the air-fuel mixture shows a tendency to ignite before the spark plug is fired and the exhaust valve is opened. This is especially critical in high compression engines (any engine with a compression ratio greater than 9.0:1), where the use of low-octane fuel will cause combustion to occur before the piston has completed its compression stroke, thereby forcing the piston down while it is still traveling upward. Fuel of the proper octane rating for your engine's compression ratio will slow the combustion process sufficiently to allow the spark plug time to ignite the mixture completely and allow time for the exhaust valve to open. If allowed to occur, spark ping, detonation, or pre-ignition may result in damage to the top of the pistons and burned exhaust valves.

DIESEL ENGINES

The early Volvo diesel engine is designed to run on No. 2 Diesel Fuel. From 1984 through 1986, Volvo diesels can run on either No. 1 or No. 2 fuel. Since diesel fuel is generally available along major truck routes, supply is not a problem, though it is wise to check in advance.

Several diesel station guides are available from fuel companies and are normally sold at diesel fuel stations. Some U.S. states and Canadian provinces require purchasers of diesel fuel to obtain a special permits. Check with your Volvo dealer or fuel supplier for regulations in your area. Volvo recommends that you buy diesel fuel from major suppliers to ensure a uniform high quality of fuel. For proper operation, diesel fuel systems must not contaminated by using inferior quality fuel. Special winter blends are available and should be used when temperatures fall below 14°F (-10°C). These fuels reduce the potential of wax deposit formation in the system and the resulting fuel flow restrictions. Most diesel fuel stations automatically switch to these blends when the cold weather approaches, but just to be sure, ask the attendant before filling up.

✻✻WARNING

There is a dramatic difference between the refinement levels of diesel fuel and home heating oil. As some diesel owners have found out the hard way, substituting home heating oil for diesel fuel will clog the fuel system with impurities and ash, resulting in the need for a major fuel system cleaning and overhaul.

Engine Oil Recommendations

Oils and lubricants are classified and graded according to standards established by the Society of Automobile Engineers (SAE), American Petroleum Institute (API) and the National Lubricating Grease Institute (NLGI). Engine oils are classified by the SAE and API designations found on the top of the oil can. The SAE grade number indicates the viscosity of engine oil. SAE 10W-40, for example, is a good all-temperature motor oil suitable for use in winter.The API classifications system defines oil performance in terms of usage. For gasoline engine Volvos, only oils designated **SE** or **SF** should be used. These oils provide sufficient additives to give maximum engine protection over a wide range of operating conditions.

Oils of the SE or SF variety performs a multitude of functions in addition to their basic task of lubricating. Through a balanced formula of metallic detergents and polymeric dispersants, the oil prevents high-temperature and low-temperature deposits and also keeps sludge and dirt particles in suspension. Acids, particularly sulfuric acid, as well as other by-products of combustion, are neutralized by the oil. These acids, if permitted to concentrate, may cause corrosion and rapid wear of the internal parts of the engine.

Volvo diesels must use SE/CC or SF/CC motor oils. Those built in 1984 and later require oil designated CD. Note that the letters CD or CF appear in addition to all the other designations on the can. A sample designation might read: SAE 15W/40 SF/CD. This indicates that the oil provides protection from rust, corrosion and high temperature deposits in diesel engines used in moderate to severe service. Use the accompanying oil temperature range charts to select the correct SAE weight motor oil for the climate in which you will be driving.

Engine

OIL LEVEL CHECK

➧ See Figures 56, 57 and 58

Always check the engine oil with the engine warm. Check the engine oil at least once a week.

With the vehicle on a level surface, allow the engine to sit at least three to five minutes after it has been shut off before checking the oil level; this will give the oil that has been circulating through the engine a chance to drip back down into the oil pan. Locate the engine dipstick: it is usually located on the left side of the engine. On the V6 engines (B28 and 280

Oil Recommendations

140, 1800 SERIES, 164

Temperature	Oil Viscosity
Above +10°F (−12°C)	SAE 20W-40 SAE 20W-50
Below +10°F (−12°C)	SAE 10W-30
Consistently below 0°F	SAE 5W-20 ①

240, 260 SERIES, ALL GASOLINE ENGINE 1980 AND LATER MODELS

Temperature	Oil Viscosity
All year round	SAE 10W-40 SAE 10W-30
Above +14°F (−10°C)	SAE 20W-50
Consistently below 0°F	SAE 5W-20 ①

① Should not be used at temperature continuously above 32°F (0°C)

DIESEL ENGINE

Temperature	Oil Viscosity
Above 86°F (+30°C)	SAE 20W-50 SAE 30W
Between 86°F (+30°C) and 14°F (−10°C)	SAE 10W-30 SAE 15W-50 SAE 20W-20
Below 14°F (−10°C)	SAE 10W-40 SAE 10W ①

① Should not be used under high engine revs or heavy engine load

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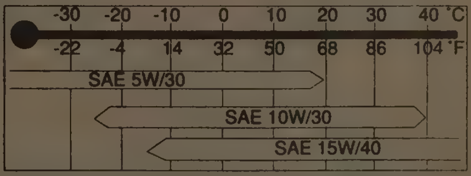
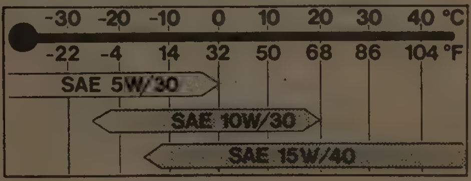


Gasoline engines, 1984 and later: Recommended oil viscosity



Diesel engines, 1984 and later: Recommended oil viscosity

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family) the dipstick is on the right side of the motor, just forward of the right side shock tower.

Remove the dipstick and clean the oil off the end with a rag. Insert the dipstick again, wait a few seconds and pull it out. The oil level should be within the cross-hatched section of the dipstick. Oil level should never drop below or rise above the cross-hatched marks. If the oil level is below or near the bottom of the cross-hatched marks, add oil of the same type and viscosity, a little at a time, until the oil level is brought back within normal operating range.

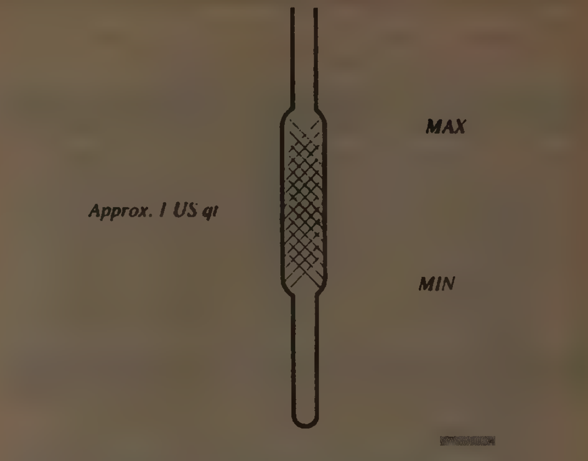

Fig. 58 Engine oil should always be within the cross-hatched area of the dipstick

OIL AND FILTER CHANGE

➧ See Figures 59, 60, 61, 62, 63, 64 and 65

➡Certain operating conditions may warrant more frequent changes. If the vehicle is used for short trips, water condensation and low-temperature deposits may make it necessary to change the oil sooner. If the vehicle is used mostly in stop-and-go city traffic, corrosive acids and high-temperature deposits may necessitate shorter oil changing intervals. The shorter intervals are also true for industrial or rural areas where high concentrations of dust contaminate the oil. Cars used for carrying heavy loads, pulling trailers, or in mountainous areas may also need more frequent oil and filter changes.

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Fig. 56 Pull the dipstick from its tube to check the engine oil level

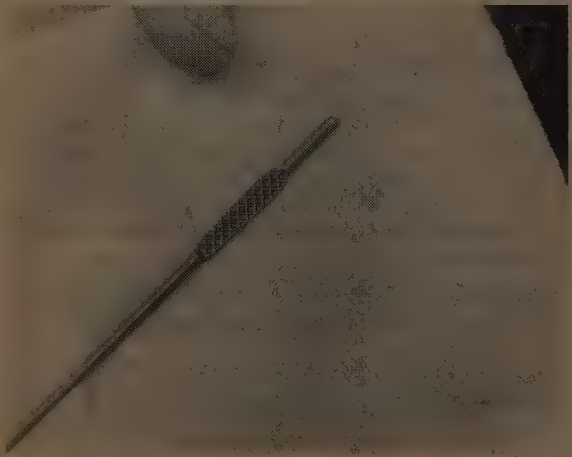
87861302

Fig. 57 Wipe the dipstick with a clean rag, then reinsert

Change the engine oil and filter according to the maintenance intervals chart in this section.

CAUTION

Used motor oil may cause skin cancer if repeatedly left in contact with the skin for prolonged periods. Although this is unlikely unless you handle oil on a daily basis, it is wise to thoroughly wash your hands with soap and water immediately after handling used motor oil.

After the engine has reached operating temperature, shut it off, place a drip pan under the sump (oil pan), and remove the drain plug. Allow the engine to drain thoroughly before replacing the plug. Make certain the drain plug is in place and tightened before continuing. Place the drip pan beneath the oil filter. To remove the filter, turn it counterclockwise with a strap wrench.

➡If necessary, brush away any accumulated dirt from the drain plug bolt prior to removing it.

Wipe the contact surface of the new filter clean of all dirt and coat the rubber gasket with clean engine oil. Also wipe clean the adaptor on the block. To install, hand-turn the new filter clockwise until the gasket just contacts the cylinder block. Do not use a strap wrench to install. Then hand-turn the filter ½ additional turn.

➡Volvo recommends replacing the oil filter at every oil change.

Unscrew the filler cap on the valve cover and fill the crankcase to the proper level on the dipstick with the recommended grade of oil. Replace the cap, start the engine, and operate at

87[illegible]1303

Fig. 59 If there is an oily mess built up around the bottom of the oil pan, first use a stiff brush to clear it away

87861304

Fig. 60 Use the correct size socket to remove the drain plug bolt

87861305

Fig. 61 Try to keep your hands out of the heavy stream that will emerge as soon as the bolt is removed

87861306

Fig. 62 Allow the engine to drain thoroughly before reinstalling the drain plug bolt

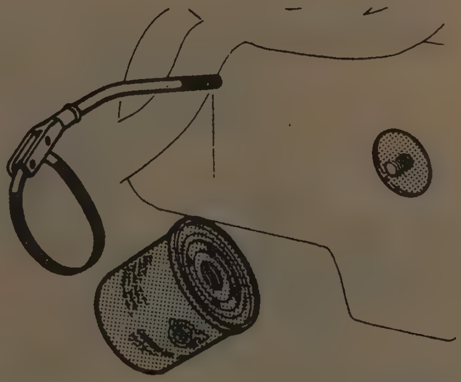

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Fig. 63 Use a strap wrench to remove — but not to install — the oil filter

fast idle. Check the oil filter contact area and the drain plug for leaks and attend to any leaks as necessary.

➡Please dispose of used motor oil properly. Do not throw it in the trash or pour it on the ground. Take it to your dealer, local service station or other oil recycling location.

Manual Transmission

FLUID RECOMMENDATION

All 140 series Volvos (without overdrive) equipped with the M40 gearbox use SAE 80 gear oil, or if none is available, SAE 30 engine oil. All 140 series Volvos with overdrive and all 1800 series Volvos equipped with the M410 gearbox use SAE 30 or SAE 20W-40 engine oil. Model 164 Volvos, without overdrive, and equipped with the M400 gearbox use SAE 90 gear oil or SAE 40 engine oil.

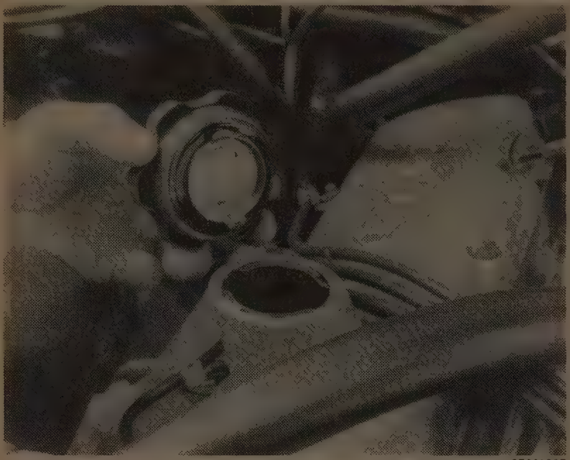
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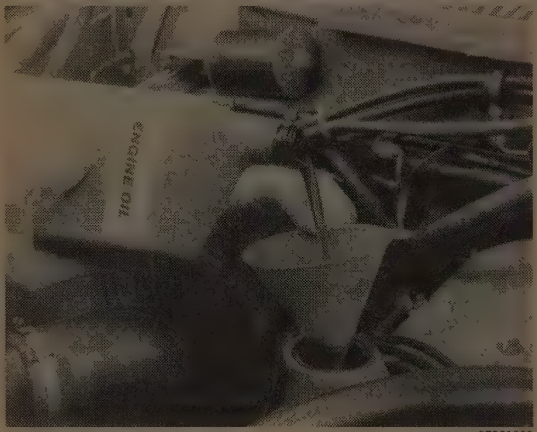
Fig. 64 Remove the filler cap to add the motor oil



87861308

Fig. 65 Use a funnel to avoid spilling the oil on the engine

1975 240 series Volvos equipped with the M40 transmission use SAE 80W/90 or SAE 80/90 gear oil, while all 1975 240 series Volvos equipped with the M41 overdrive transmission use SAE 30 or SAE 20W-40 oil.

On a number of 1976 240 series and 260 series models equipped with the M45 transmission and the M46 overdrive transmission, the transmissions are filled with SAE 80W/90 or SAE 80/90 gear oil, while all other M45 and M46 transmissions (used on 1976-88 models) are filled with Type F or Type G automatic transmission fluid. You are reading that correctly; automatic transmission fluid in a manual (stick shift) transmission. An easy way to tell if the transmission uses gear oil or ATF is: on ATF filled transmissions, the figure eight shaped flat casting located at the filler plug is stamped "ATF-OIL" in white. Do not attempt to use gear oil in these transmissions, or vice versa. The M47 5-speed transmission introduced in 1987 also uses Type F or G fluid.

LEVEL CHECK

At 6000 to 7500 mile (9662-12,077 km) intervals, the fluid level should be checked. After making sure that the vehicle is standing on level ground, unscrew the filler plug and check to see that the fluid level is even with the bottom of the filler plug hole or just flowing out of it. Top up, as necessary, with the recommended gear oil.

➡On vehicles with overdrive units, the overdrive gears are lubricated by the transmission oil; no separate filler plug is used.

DRAIN AND REFILL

➧ See Figures 66 and 67

Once the transmission has reached operating temperature (after being driven 5-7 miles or 8-11 km), the oil may be changed.

1. Place a drip pan beneath the vehicle, then remove the drain plug and the filler plug. On vehicles equipped with overdrive, remove the six bolts and cover, allowing the unit to also drain.
2. At this time, the pre-filter and fine filter must be removed and cleaned in solvent. To remove the fine filter, Volvo special tool no. 2836, or an equivalent removal tool, must be used to unscrew the filter housing. After blowing the filters dry with compressed air, install the fine filter in its socket with a new seal. Tighten the plug for the filter housing with special tool no. 2836 or similar to 16 ft. lbs. (22 Nm). Install the pre-filter and the cover with a new gasket making sure that the magnet is in place. On overdrive units from 1983, the strainer is external; it will come off with the cover and can be easily cleaned.
3. Install the drain plug.
4. Fill the transmission to the filler plug opening with the proper oil, then install the filler plug.

✲✲WARNING

Allow the oil time to seep into the overdrive unit on vehicles so equipped before driving the car.

Automatic Transmission

FLUID RECOMMENDATION

Until 1983, all Volvo automatic transmissions used type F automatic transmission fluid. 1979-83 models can also use type G automatic transmission fluid.

From 1983 on, transmissions designated AW 70, AW 71 and ZF 4 HP 22 use fluid identified as Dexron®II. Only the BW 55 transmission continued to use Type F or G fluid.

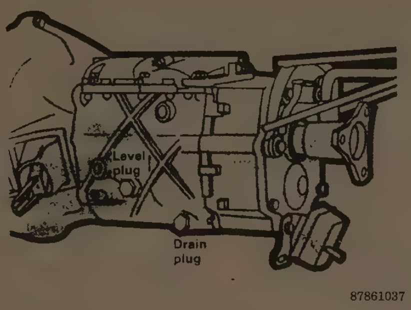

Level plug
Drain plug
87861037

Fig. 66 Drain and refill locations — manual 5-speed transmission

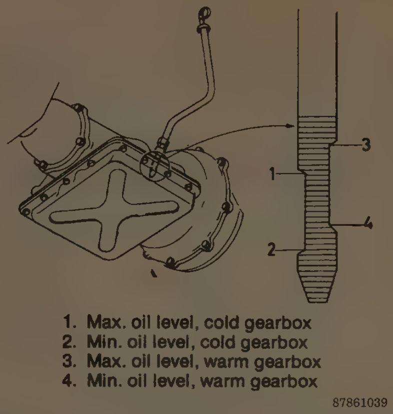

3
1
4
2
1. Max. oil level, cold gearbox
2. Min. oil level, cold gearbox
3. Max. oil level, warm gearbox
4. Min. oil level, warm gearbox
87861039

Fig. 68 Certain models utilize a notched ATF dipstick — wipe and carefully read, making sure to look at the correct level marking

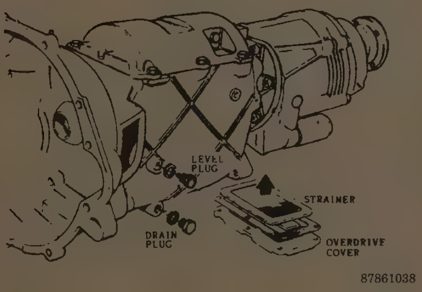

LEVEL PLUG
STRAINER
DRAIN PLUG
OVERDRIVE COVER
87861038

Fig. 67 Drain and refill locations — manual 4-speed transmission with overdrive

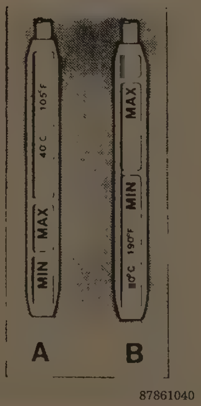

105°F
40°C
MAX
MIN
MAX
MIN
190°F
80°C
A
B
87861040

Fig. 69 Gauge the ATF level on the correct dipstick scale, as determined by the gearbox temperature

LEVEL CHECK

➧ **See Figures 68 and 69**

The fluid level of the automatic transmission should be checked every 6000-7500 miles (9662-12,077 km). Position the vehicle on level ground, place the selector lever in Park, and let the engine idle. Remove the dipstick from the filler tube on the right side of the engine, and wipe it clean with a chamois or similar lint-free cloth. Reinsert the dipstick, pull it straight out, and take the reading. Any transmission that has been driven for 5-7 miles (8-11 km) is a warm transmission and its proper level is the upper range of marks on the dipstick. The proper level for a cold transmission is the lower range of marks. When necessary, top up with the proper automatic transmission fluid. The difference between the minimum and maximum marks is only one pint, so add the fluid slowly. Overfilling the transmission may cause it to overheat.

On many later model automatic transmission cars, the transmission dipstick is calibrated on both sides: one for cold ATF fluid — below 105°F (41°C) and one for warm fluid — above 190°F (88°C). The fluid temperature will be in the warm range after 20 to 30 minutes of driving. Be sure to read the appropriate side when checking the fluid level.

DRAIN AND REFILL

➧ **See Figure 70**

Up to 1983, the oil in the automatic transmission need only be changed when the unit is torn down for repairs or rebuilding. In normal use, only topping up the fluid is required as needed. Internal repairs or rebuilding is best referred to a Volvo service agency.

During the model year 1983, Volvo began to equip all automatic transmissions with an oil drain plug in the bottom of the pan. The drain and refill interval was established at 20,000 miles (32,206 km) for all cars from 1983 to the present. Again, adverse operating conditions may dictate more frequent changes. Fresh transmission oil is very cheap insurance in a very expensive unit. To drain the transmission:

1. With the engine off and the rear wheels blocked, safely elevate the front of the car and support with jackstands.
2. Position a drain pan under the transmission drain plug and carefully remove the plug.

**CAUTION

The oil can be scalding hot if vehicle was recently driven.

3. After the oil has drained, reinstall the drain plug and tighten.
4. Disconnect and remove the dipstick tube from the pan. Remove the bolts holding the pan to the transmission body and remove the pan.
5. Clean the oil pan, strainer, particle magnet and other removed parts.
6. Reinstall the strainer and magnets, making certain that each part is in its proper place.
7. Place a new gasket on the oil pan and lightly coat it with fresh ATF. Reinstall the oil pan to the transmission body and install the bolts; make sure the gasket is properly placed on the pan before installing. When tightening the pan bolts, do not overtighten. Tighten them only to 3.5 ft. lbs (5 Nm); overtightening will deform the pan, crush the gasket, and cause oil leaks. If the transmission pan uses retaining clips, make sure they are properly positioned to match the pan shape; tighten these bolts to 4 ft. lbs. (6 Nm).
8. Reinstall the dipstick tube, making certain that it is properly threaded before tightening. Correct torque is 60-65 ft. lbs. (81-88 Nm).
9. Using a funnel, deliver the correct amount of automatic transmission fluid through the dipstick tube under the hood.
10. Remove all items from under the car, return it to the ground, and start the engine. Allow it to warm up fully and check for leakage at the drain plug, gasket, and dipstick tube. Attend to leaks as necessary.

Rear Axle

FLUID RECOMMENDATION

All Volvo rear axles use API GL-5 SAE 90W gear oil. For climates where the temperature is constantly below 15°F (-10°C), API GL-5 SAE 80W oil can be used. On cars with limited slip differentials, use oils with the proper additives to protect these units.

LEVEL CHECK

Check the rear axle fluid level at least twice a year. The vehicle must be level and, if raised on jackstands, both ends of the car must be raised the same amount. To check the oil level, remove the filler plug in the back of the differential case. Gear oil should be even with or just flowing out of the filler hole. If not, add the specified gear oil; on cars equipped with limited slip differentials, use only gear oil with the appropriate additives.

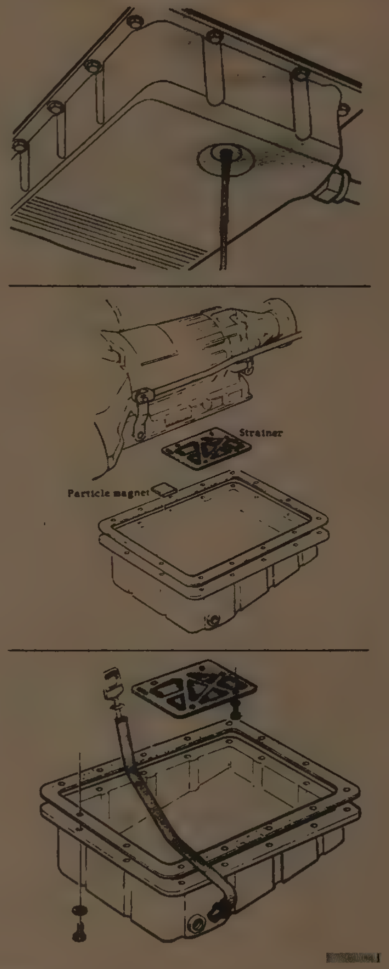


Fig. 70 Drain the ATF into a container, then remove the pan from the transmission; clean and install the pan using a new gasket

DRAIN AND REFILL

See Figures 71, 72, 73, 74, 75 and 76

The oil in the rear axle is changed after the first 1200-1500 miles (1932-2415 km), and thereafter only if the unit is rebuilt.

1. Position a suitable container beneath the drain plug.
2. Remove the drain plug, allowing the warm oil to drain into a container.
3. Clean the drain plug of all metal filings and foreign impurities, then reinstall the drain plug.
4. Remove the filler plug. Fill the axle to the bottom of the filler hole with API GL-5 SAE 90 gear oil.
5. Clean, then reinstall the filler plug.

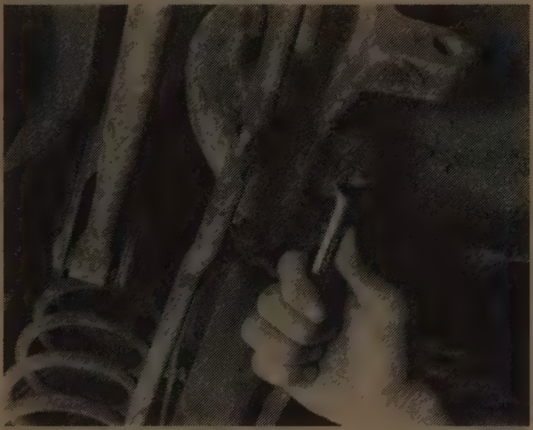

87861340

Fig. 71 To drain the rear axle gear oil, place a drain pan beneath, then remove the square headed drain plug

87861341

Fig. 72 Hold onto the plug to keep it from falling into the drain pan — have shop rags ready to clean your hands, etc.

87861342

Fig. 73 First clean any oily dirt, etc. from the filler hole to keep dirt out of the differential

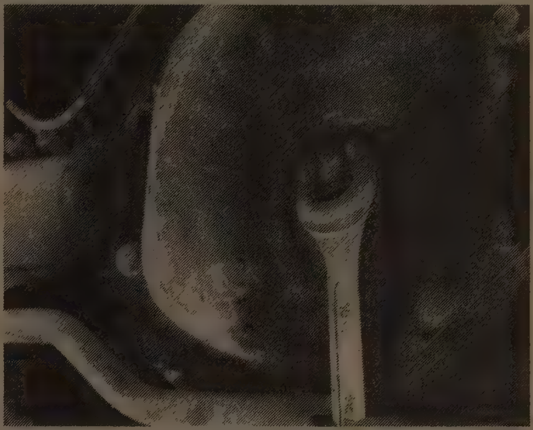


Fig. 74 Remove the plug to add gear oil to the differential

87861344

Fig. 75 With the car raised level, add gear oil until it is just even with the lower threads of the hole, then install the plug and wipe off any drips

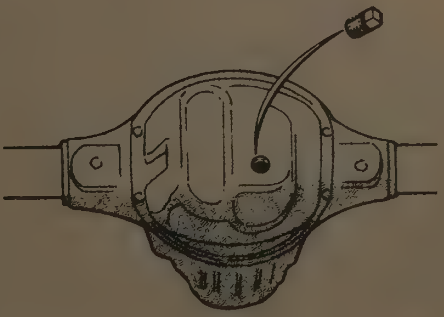

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Fig. 76 Rear axle filler plug location

Cooling System

FLUID RECOMMENDATION AND LEVEL CHECK

See Figures 77, 78 and 79

Check the coolant level at fuel stops on all models. The level should appear between the maximum and minimum marks of the translucent expansion tank. Do not remove the expansion tank filler cap except to top off the system, as air might become trapped in the system and reduce cooling efficiency. Top off the system with a mixture of 50% antifreeze and 50% water; use this mixture all year round. If the engine is warm when you top off the cooling system, remove the filler cap slowly in order to allow any excess pressure to escape.

CAUTION

Always check or add fluid at the expansion tank. NEVER remove the cap from a hot radiator. You can be badly scalded by steam and hot liquid.

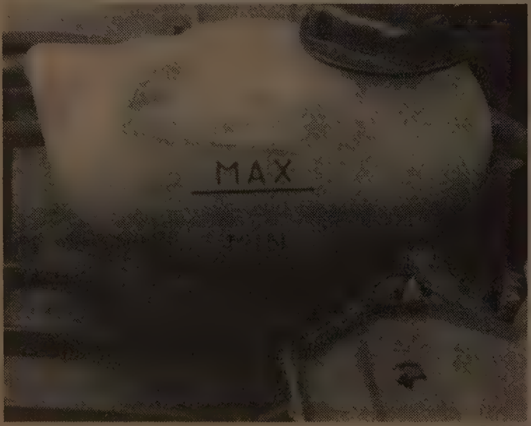

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Fig. 77 Check the coolant level at fuel stops — It should be between the "MAX" and "MIN" marks

87861346

Fig. 78 Remove the expansion tank filler cap only to add fluid

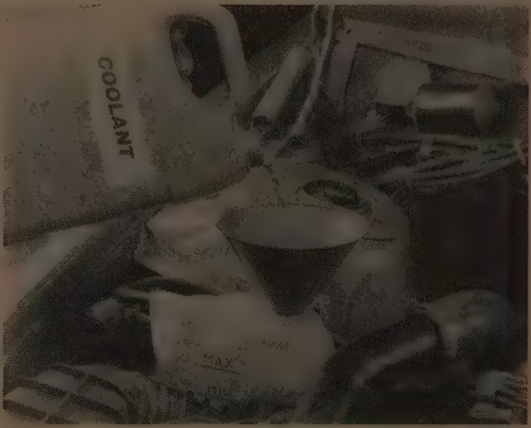

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Fig. 79 Use a funnel to add a 50/50 coolant and water mixture. This ratio should be used year-round

DRAIN AND REFILL

Perform this operation with the engine cold.

1. Raise and safely support the front of the car on jackstands.
2. Remove the gravel shield, if equipped. Remove the expansion tank cap and set the heater controls to Hot.

CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant can be reused unless it is contaminated or several years old.

3. Open the petcock on the right side of the engine block on all but the V6 engine and the diesel. The V6 engine petcocks are located on both sides of the block. The diesel engine does not have an accessible block drain and must be drained at the radiator. If the coolant is to be reused, collect it in a clean pan.
4. On all models, while the block is draining, disconnect the lower radiator hose and allow the coolant to drain into another pan. On models with an expansion tank, either use a siphon or unfasten the tank and hold it up so that all of the coolant in it flows into the radiator.
5. Close the petcock(s), reconnect the lower radiator hose and add coolant to the expansion tank until coolant is level with the MAX mark on the tank.
6. Run the engine to normal operating temperature and check for leaks. Check the coolant level and refill if necessary.

FLUSHING AND CLEANING THE SYSTEM

Proceed with draining the system as previously outlined. When the system has drained, reconnect hoses and secure as necessary. Move the temperature control for the heater to its hottest position; this allows the heater core to be flushed as well. Using a garden hose, fill the radiator and allow the water to run out the engine draincocks. Continue until the water runs clear. Be sure to clean the expansion tank as well.

If the system is badly contaminated with rust or scale, you can use a commercial flushing solution to clean it out. Follow the manufacturer's instructions. Some causes of rust are air in the system, failure to change the coolant regularly, use of excessively hard or soft water, and/or failure to use the correct mix of antifreeze and water.

After the system has been flushed, continue with the refill procedures outlined previously. Check the condition of the radiator cap and its gasket, replacing the cap if anything looks improper.

➡Volvo specifies that the cooling system on diesel engines must be bled after refilling the cooling system. This eliminates trapped air from the system and insures proper operation.

To bleed the diesel cooling system, perform the following:

1. Disconnect the upper hose running to the cold start device on the right side of the engine.
2. Place a drain pan under the hose and hold the hose approximately at the same height as the top of the expansion tank.
3. Fill the cooling system through the expansion tank, then start the engine and run at fast idle.
4. Run the engine for five minutes and continue to fill the cooling system during this time. Reconnect the hose to the cold start device.
5. Continue to fill the cooling system until the correct level is reached, then reinstall the cap on the expansion tank.

Brake Master Cylinder

FLUID RECOMMENDATION AND LEVEL CHECK

➧ See Figures 80, 81 and 82

The level of brake fluid in the master cylinder should be checked weekly. The master cylinder is located on the left side of the engine compartment in front of the firewall. The level may be checked without removing the cap by simply observing whether or not the fluid is up to the maximum mark on the translucent reservoir. Top up as necessary with DOT 4 quality fluid. Take care not to drop any foreign matter or dirt into the reservoir. Make sure that the vent hole in the reservoir cap is not blocked. Always wipe off the cap and reservoir area before opening the reservoir; this will help assure that no dirt gets into the fluid.

**WARNING

Do not allow brake fluid to come in contact with any painted surfaces of the car. If this occurs, immediately rinse the area with clear water.

Clutch Master Cylinder

FLUID RECOMMENDATION AND LEVEL CHECK

➧ See Figure 83

The 260 series vehicles, as well as 1980 and later models with a V6 engine and manual transmission, are equipped with a hydraulic clutch release system rather than the cable clutch release used on other Volvos. You can check the fluid level

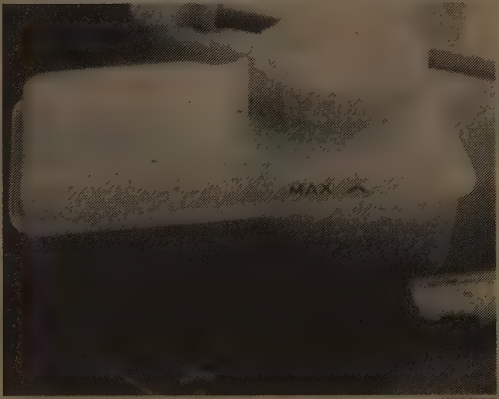
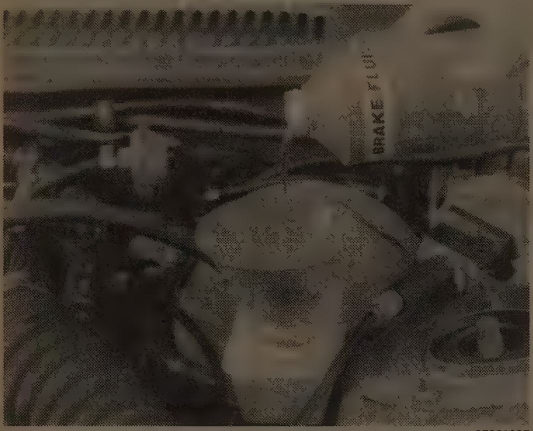


Fig. 80 It's a good idea to get into the habit of monitoring the brake fluid level — the translucent reservoir lets you know it's full to the "MAX"

Fig. 81 Remove the cap to add brake fluid



87861327

Fig. 82 Use a funnel to add clean fluid to the "MAX" line and refasten the cap securely

without removing the master cylinder cap by looking through the translucent sides of the reservoir. If fluid is not even with the MAX line, add DOT 4 brake fluid through the capped opening.

✲✲WARNING

Do not allow brake fluid to come in contact with any painted surfaces of the car. If this occurs, immediately rinse the area with clear water.

Manual Steering Gear

FLUID RECOMMENDATION AND LEVEL CHECK

142, 144, 145, and 1800 Models

These models use a worm and roller type steering gear box. The oil level should be to the bottom of the filler plug in the gear box. Check the oil level at least twice a year and top up, if necessary, using the recommended oil.

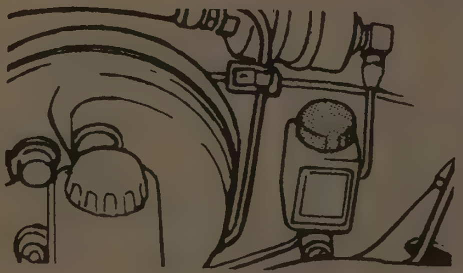


Fig. 83 Location of the clutch master cylinder — 260 series and 1980-89 V6-equipped vehicles with manual transmission

242, 244, and 254 Models

➧ See Figure 84

These models are equipped with a rack and pinion manual steering system which is permanently filled with lubricant. Two different types of rack and pinion systems are used, one manufactured by ZF and one by Cam. The ZF system is packed with grease while the Cam system is filled with 20W-50 motor oil. On both types, check the rubber bellows boots for rips and degeneration. If a ripped boot is noticed, replace it as soon as possible. Refer to Section 8 of this manual for more information.

Power Steering Pump

FLUID RECOMMENDATION AND LEVEL CHECK

➧ See Figures 85 and 86

142, 144, 145, and 164 Models

Check the power steering reservoir fluid level at least twice a year. With the engine shut off the fluid level should appear approximately ¼ in. above the level mark inside the reservoir. Top up as necessary with Type A automatic transmission fluid or Dexron®II. Top up the system only with engine off to prevent air from being sucked into the system.

If necessary, bleed the air out of the system according to the instructions given in Section 8.

200 and 700 Series Models

➧ See Figures 87, 88, 89 and 90

Check the power steering reservoir fluid level at least twice a year. On the 240 series (242, 244 and 245 models) through 1976, check the oil level with the engine running. Level should be at the level mark on the inside of the reservoir. The oil level will rise when the engine is stopped.

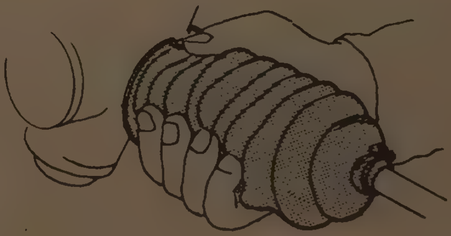


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Fig. 84 On vehicles equipped with rack and pinion steering, check the bellows boots for cracks and rips

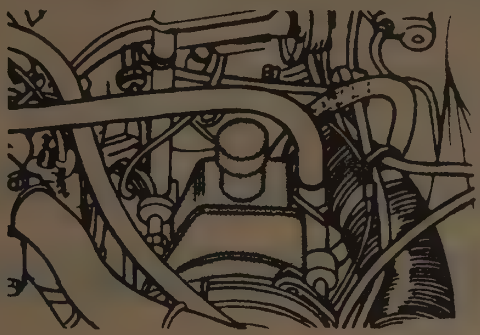

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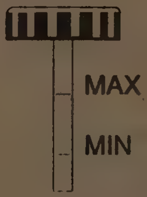
Fig. 85 Check the power steering fluid with the dipstick under the cap. Some models utilize a translucent reservoir



87861047

Fig. 86 Add power steering fluid if necessary until it reaches the MAX mark

87861316

Fig. 87 To check the power steering fluid level, turn the cap counterclockwise, then remove and read the attached dipstick

87861317

Fig. 88 If the engine is not up to operating temperature, use the "COLD" level mark on the dipstick — if unsure, let the engine warm up and check it when hot

On all other models, the fluid level is checked with the engine running and the fluid hot (after driving). The fluid level should be between the MAX and MIN marks which are located either on the side of the translucent plastic reservoir or on the dipstick attached to the filler cap. Add automatic transmission fluid, Type A, F, or G as necessary. If necessary, bleed the air out of the system according to the instructions given in Section 8.

It should be noted that the power steering fluid is never drained and replaced as a maintenance procedure. If you are constantly adding fluid, the system is leaking somewhere and requires prompt attention.

87861318

Fig. 89 If the engine was running long enough to reach full operating temperature, use the dipstick's "HOT" marking when checking the fluid level

POWER STEERING FLUID

87861319

Fig. 90 Add power steering fluid as necessary using a clean funnel — add the fluid incrementally to avoid overfilling the reservoir

Carburetor Oil

FLUID RECOMMENDATION AND LEVEL CHECK

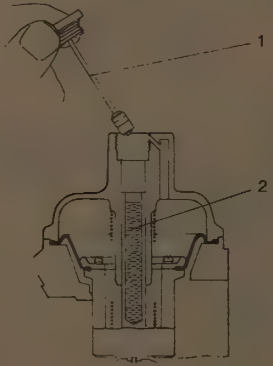
➧ **See Figure 91**

On carbureted 1970-72 series, 164 series and Canadian models, the oil level in the center spindle of the carburetors must be checked every six months or 6000 miles (9662 km). Unscrew the black knob on top of each carburetor and remove each damping plunger. The oil level should be maintained at about ¼ in. from the edge of the spindle. Top up as necessary with automatic transmission fluid Type A, or Dexron®II.

Chassis Greasing

Aside from the yearly greasing of all the joints for the throttle linkage, parking brake, and pedal linkages, no regular greasing of front-end components or universal joints is required. Use regular chassis lube on the above-mentioned joints once a year or if binding is noticed.

The upper and lower control arm ball joints as well as the tie rod and steering rod ball joints are lined with plastic (Teflon®) and do not require lubrication. However, every 12,000 miles (19,324 km), check the rubber seals of these ball joints for cracking or damage. Replace any damaged seal with a new one, making sure to pack the new seal with multipurpose chassis grease.



1. Damper piston
2. Oil (ATF fluid type "A")

87861048

Fig. 91 Check the carburetor oil (on models so equipped) every six months or 6000 miles (9662 km)

Distributor Lubrication

BREAKER POINT IGNITION

➧ **See Figure 92**

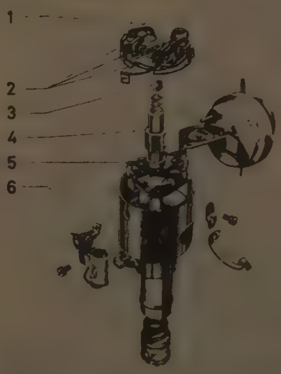
Every six months or 6000 miles (9662 km), the distributor shaft, cam lobes, and advance mechanism are lubricated. To lubricate the distributor shaft, fill the oil cup on the side of the distributor with light engine oil. The cam lobes are lightly smeared with a suitable silicone cam lobe grease. The advance mechanism is lubricated by pouring two or three drops of SAE 10W engine oil on the wick of the distributor shaft.

ELECTRONIC IGNITION

Since there is no rubbing block, cam, or breaker points in the electronic ignition system, the only lubrication required is to remove the distributor cap and rotor and soak the felt wick in the distributor shaft center with one or two drops of motor oil.

➡**If you cannot remove the distributor cap because it seems to be catching on something, rotate the engine to a different position by hand, then remove the cap.**

When oiling the felt wick, be very careful not to splash any oil on the impulse sender or any other electronic ignition components inside the distributor.



1. Grease contact lip
2. Grease
3. Lubricate
4. Grease very lightly
5. Grease
6. Fill with oil

87861049

Fig. 92 Exploded view of a common breaker point ignition distributor

Body Lubrication

➧ See Figure 93

In order to avoid rattles and unnecessary wear, lubricate the body parts as shown on the diagram every 6000-7000 miles (9662-11,250 km) or twice a year.

Wheel Bearings

ADJUSTMENT & PACKING

➧ See Figures 94, 95 and 96

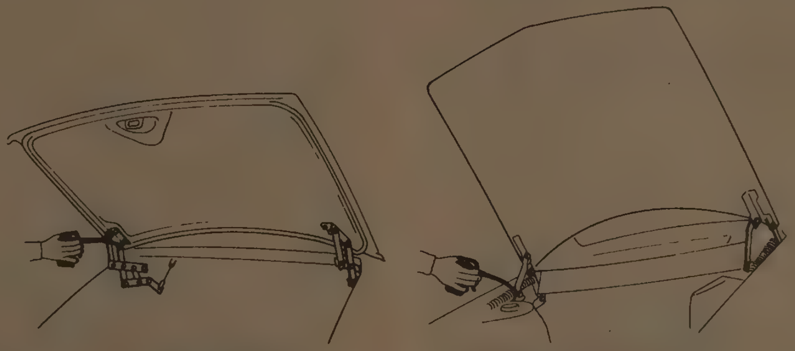
The rear wheel bearings are not adjustable and are lubricated by the rear axle oil. The front wheel bearings are replaced and adjusted as explained below. Note that you will need either Volvo special tools or their equivalent to perform the service.

1. Remove the hub cap, and loosen the lug nuts a few turns.
2. Firmly apply the parking brake and block the rear wheels. Jack up the front of the car and place jackstands beneath the jacking points. Remove the front wheels.
3. Remove the front caliper as outlined in Section 9.

✻✻CAUTION

Brake pads and shoes may contain asbestos, which has been determined to a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling and dust from brake surfaces! When cleaning brakes, use commercially available brake cleaning fluids.

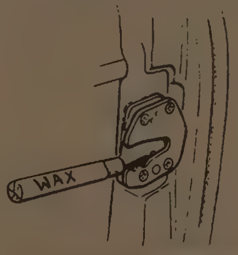
4. Pry off the grease cap from the hub. Remove the cotter pin and castle nut. Use a hub puller to pull off the hub. On the 760 GLE remove the brake disc. If the inner bearing remains lodged on the stub axle, remove it with a puller.



Lubrication point—trunk hinges

Lubrication point—engine hood hinges

No. Lubricating point	Lubricant
1. Hood lock and latch	Parafin wax
2. Hood hinges	Oil
3. Door stop	Oil
4. Sunroof wind deflector	Oil
5. Door lock catch plate	Parafin wax
6. Trunk lid lock	Lock oil
7. Window regulator	Oil, grease
Locking device (on inside of door)	Silicone grease
8. Front seat slide rail and latch	Oil



Lubrication point—door stop

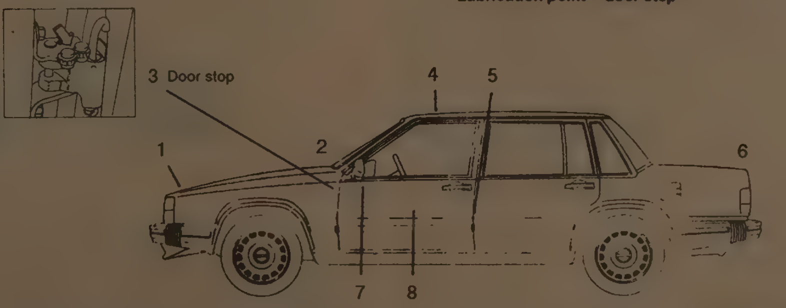


Fig. 93 Lubricate these points at least twice a year — all models

5. Using a drift, remove the inner and outer bearing rings.
6. Thoroughly clean the hub, brake disc, and grease cap.
7. Press in the new inner and outer bearing rings with a drift or bearing installation tool.
8. Press grease onto both bearings with a bearing packer. If one is not available, pack the bearings with as much wheel bearing grease as possible by hand. Also coat the outside of the bearings and the outer rings pressed into the hub. Fill the recess in the hub with grease up to the smallest diameter on the outer ring for the outer bearing. Place the inner bearing in position in the hub and press its seal in with a drift. The felt ring should be thoroughly coated with light engine oil.
9. Place the hub onto the stub axle. Install the outer bearing, washer, and castle nut.
10. Adjust the front wheel bearings by tightening the castle nut to 45 ft. lbs. (61 Nm) to seat the bearings. Then, back off the nut ⅓ of a turn counterclockwise. Tighten the nut to 12 inch lbs. (1.35 Nm). If the nut slot does not align with the hole in the stub axle, tighten the nut until the cotter pin may be installed. Make sure that the wheel spins freely without any side play.
11. Fill the grease cap halfway with wheel bearing grease, and install it on the hub.
12. Install the front caliper.
13. Install the wheels. Remove the jackstand and lower the car. Tighten the lug nuts to 60-70 ft. lbs. (81-95 Nm) and install the hub cap.

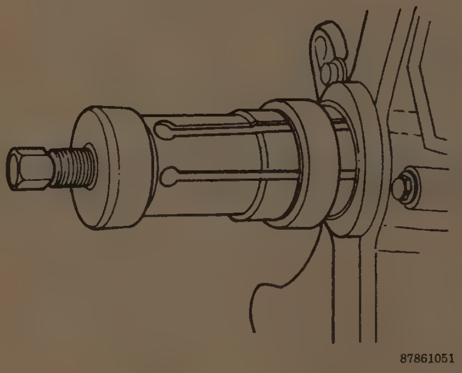


Fig. 94 Remove the inner bearing with a puller — special Volvo tool shown

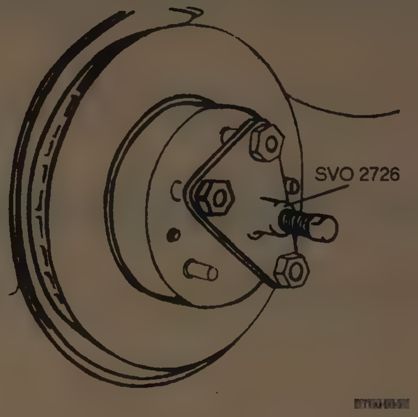


Fig. 95 Use a puller, such as the special Volvo tool shown, to remove the front hub

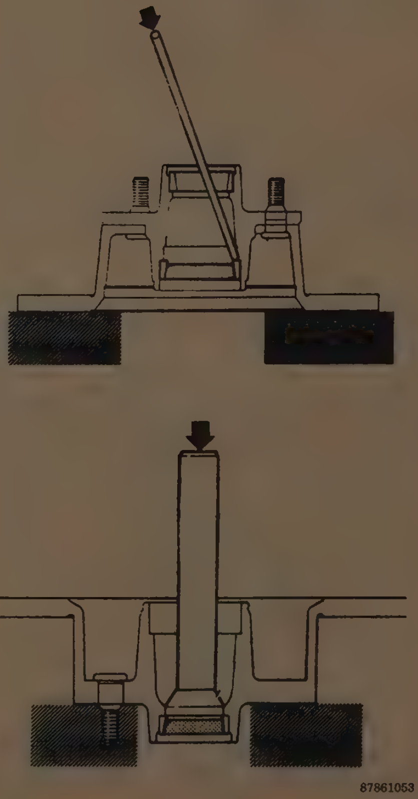


Fig. 96 Above: use a drift to remove the inner bearing race
Below: use a bearing removal tool to remove the outer race

TRAILER TOWING

Trailer and Tongue Weight Limits

Trailer weight is the first and most important factor in determining whether or not your vehicle is suitable for towing the trailer you have in mind. The horsepower-to-weight ratio should be calculated. The basic standard is a ratio of 35:1. That is, 35 pounds of GVW for every horsepower.

To calculate this ratio, multiply your engine's rated horsepower by 35, then subtract the weight of the vehicle, including passengers and luggage. The resulting figure is the ideal maximum trailer weight that you can tow. One point to consider: a numerically higher axle ratio can offset what appears to be a low trailer weight. If the weight of the trailer that you have in mind is somewhat higher than the weight you just calculated, you might consider changing your rear axle ratio to compensate.

For vehicles produced up to the end of 1982, Volvo recommends a maximum trailer weight of 2000 lbs. (908 kgs) with a tongue weight of 200 lbs. (90 kgs). In 1983, the limits were generally raised to a maximum of a 3300 lb. trailer (1500 kgs) and an absolute maximum tongue weight of 200 lbs. (90 kgs). The 780 family is the only exception to this rule, having a maximum recommended trailer weight of 1985 lbs. (900 kgs) with a tongue weight of 110 lbs. (50 kgs). A general rule is that the tongue weight of the trailer should never exceed ten percent of the total weight of the trailer.

Cars with overdrive transmissions must not use the overdrive when towing. Volvo recommends the installation of a transmission oil cooler when towing heavy trailers; this will allow the transmission to operate closer to its normal temperature range. When towing, remember that the engine and transmission are subjected to heavier than normal load; engine temperature should be watched closely for overheating and fluids should be checked regularly.

Hitch Weight

There are three kinds of hitches: bumper mounted, frame mounted, and load equalizing.

Bumper mounted hitches are those which attach solely to the vehicle's bumper. Many states prohibit towing with this type of hitch when it attaches to the vehicle's stock bumper, since it subjects the bumper to stresses for which it was not designed. Aftermarket rear step bumpers, designed for trailer towing, are acceptable for use with bumper mounted hitches.

Frame mounted hitches can be of the type which bolts to two or more points on the frame, plus the bumper, or just to several points on the frame. Frame mounted hitches can also be of the tongue type, for Class I towing, or of the receiver type, for classes II and III.

Load equalizing hitches are usually used for large trailers. Most equalizing hitches are welded in place and use equalizing bars and chains to level the vehicle after the trailer is hooked up.

The bolt-on hitches are the most common, since they are relatively easy to install.

Check the gross weight rating of your trailer. Tongue weight is usually figured as 10 percent of gross trailer weight. Therefore, a trailer with a maximum gross weight of 2000 lbs. (900 kgs) will have a maximum tongue weight of 200 lbs. (90 kg). Class I trailers fall into this category. Class II trailers are those with a gross weight rating of 2000-3500 lbs. (900-1600 kgs), while Class III trailers fall into the 3500-6000 lb. (1600-2700 kg) category. Class IV trailers are those over 6000 lbs. (2700 kgs) and are for use with fifth wheel trucks, only.

When you've determined the hitch that you'll need, follow the manufacturer's installation instructions exactly, especially when it comes to fastener torque specifications. The hitch will subjected to a lot of stress and good hitches come with hardened bolts. Never substitute an inferior bolt for a hardened bolt.

Wiring

Wiring the car for towing is fairly easy. There are a number of good wiring kits available and these should be used, rather than trying to design your own. All trailers will need brake lights and turn signals as well as tail lights and side marker lights. Most states require extra marker lights for overwide trailers. Also, most states have recently required back-up lights for trailers, and most trailer manufacturers have been building trailers with back-up lights for several years.

Additionally, some Class I, most Class II and just about all Class III trailers will have electric brakes.

Add to this number an accessories wire, to operate trailer internal equipment or to charge the trailer's battery, and you can have as many as seven wires in the harness.

Determine the equipment on your trailer and buy the wiring kit necessary. The kit will contain all the wires needed, plus a plug adapter set which included the female plug, mounted on the bumper or hitch, and the male plug, wired into, or plugged into the trailer harness.

When installing the kit, follow the manufacturer's instructions. The color coding of the wires is standard throughout the industry.

One point to note: some domestic vehicles, and most imported vehicles, have separate turn signals. On most domestic vehicles, the brake lights and rear turn signals operate with the same bulb. For those vehicles without separate turn signals, you can purchase an isolation unit so that the brake lights won't blink whenever the turn signals are operated, or, you can go to your local electronics supply house and buy four diodes to wire in series with the brake and turn signal bulbs. Diodes will isolate the brake and turn signals. The choice is yours. The isolation units are simple and quick to install, but far more expensive than the diodes. The diodes, however, require more work to install properly, since they require the cutting of each bulb's wire and soldering in place of the diode.

One, final point, the best kits are those with a spring loaded cover on the vehicle mounted socket. This cover prevent dirt and moisture from corroding the terminals. Never let the vehicle socket hang loosely; always mount it securely to the bumper or hitch.

Cooling

ENGINE

One of the most common, if not THE most common, problems associated with trailer towing is engine overheating.

With factory installed trailer towing packages, a heavy duty cooling system is usually included. Heavy duty cooling systems are available as optional equipment on most Volvo vehicles, with or without a trailer package. If you have one of these extra-capacity systems, you shouldn't have any overheating problems.

If you have a standard cooling system, without an expansion tank, you'll definitely need to get an aftermarket expansion tank kit, preferably one with at least a 2 quart capacity. These kits are easily installed on the radiator's overflow hose, and come with a pressure cap designed for expansion tanks.

Another helpful accessory is a Flex Fan. These fan are large diameter units are designed to provide more airflow at low speeds, with blades that have deeply cupped surfaces. The blades then flex, or flatten out, at high speed, when less cooling air is needed. These fans are far lighter in weight than stock fans, requiring less horsepower to drive them. Also, they are far quieter than stock fans.

If you do decide to replace your stock fan with a flex fan, note that if your Volvo has a fan clutch, a spacer between the flex fan and water pump hub will be needed.

Aftermarket engine oil coolers are helpful for prolonging engine oil life and reducing overall engine temperatures. Both of these factors increase engine life.

While not absolutely necessary in towing Class I and some Class II trailers, they are recommended for heavier Class II and all Class III towing.

Engine oil cooler systems consist of an adapter, screwed on in place of the oil filter, a remote filter mounting and a multi-tube, finned heat exchanger, which is mounted in front of the radiator or air conditioning condenser.

TRANSMISSION

An automatic transmission is usually recommended for trailer towing. Modern automatics have proven reliable and, of course, easy to operate, in trailer towing.

The increased load of a trailer, however, causes an increase in the temperature of the automatic transmission fluid. Heat is the worst enemy of an automatic transmission. As the temperature of the fluid increases, the life of the fluid decreases.

It is essential, therefore, that you install an automatic transmission cooler.

The cooler, which consists of a multi-tube, finned heat exchanger, is usually installed in front of the radiator or air conditioning compressor, and hooked inline with the transmission cooler tank inlet line. Follow the cooler manufacturer's installation instructions.

Select a cooler of at least adequate capacity, based upon the combined gross weights of the Volvo and trailer.

Cooler manufacturers recommend that you use an aftermarket cooler in addition to, and not instead of, the present cooling tank in your Volvo radiator. If you do want to use it in place of the radiator cooling tank, get a cooler at least two sizes larger than normally necessary.

One note: the transmission cooler can, sometimes, cause slow or harsh shifting in the transmission during cold weather, until the fluid has a chance to come up to normal operating temperature. Some coolers can be purchased with or retrofitted with a temperature bypass valve which will allow fluid flow through the cooler only when the fluid has reached operating temperature, or above.

PUSHING AND TOWING

See Figure 97

➡Do not ever push your Volvo with another vehicle as possible mismatching of bumper heights, especially over undulating road surfaces, may result in rear end body damage.

Any Volvo may be towed by attaching a tow line to the towing loop located beneath the car on the front axle member. The 164 model, as well as the 140, 240, 260 series and all later Volvos, may also be towed from the rear by the towing loop under the spare wheel housing or under the rear bumper. Note that the front tow loop may be hidden behind a swing down panel in the front spoiler (below the bumper) on some models. The panel is easily opened with a small screwdriver. Never attach a tow line to the bumper.

CAUTION

When towing the car on a rope or chain, the steering must be unlocked. Remember that the power assists for steering and brakes are inoperative when the engine is off. The brake and steering systems will still operate, but will require 3-4 times the normal effort.

If the car is equipped with an automatic transmission, special precautions must be taken. The car must be towed with the selector lever in the Neutral (N) position. If the fluid level is correct in the transmission, the car may be towed a maximum distance of 20 miles (32 km) at a maximum towing speed of 20 mph (32 kph). If the transmission is faulty, or if it is necessary to tow the car for a distance greater than 20 miles (32 km), the driveshaft must be disconnected, or the car must be towed with the rear wheels raised. Failure to observe these precautions may result in damage to the automatic transmission.

If your Volvo fails to start and is equipped with a manual transmission, it may be started by towing. The towing vehicle should start out smoothly and be driven at an even speed. Switch the ignition **ON** and depress the clutch. On carbureted models, pull out the choke fully if the engine is cold. Do not pump the accelerator pedal. Place the transmission in third gear and, as the towing car picks up speed, gradually release the clutch. Once the engine fires, depress the clutch pedal and feather the gas, so as not to collide with the friend who is towing you.

Cars with automatic transmission MAY NOT be started by towing. If the battery is dead, the car may be started with the use of jumper cables. See the following section on Jump Starting. Never use a high-speed battery charger as a starting aid on fuel-injected models, as serious damage to the electronic components may result. If the high-speed charger is used to recharge the battery, the engine must be turned off and the battery completely disconnected from the car's electrical system.

Tow Trucks

If it becomes necessary to tow your Volvo with a tow truck, carefully observe the placement of hooks, slings and chains. Through 1987, Volvos can be towed using conventional slings and J-hooks. From 1988 on, it is recommended that the car ONLY be towed by wheel-lift equipment or transported on a flatbed. Hooking slings under the 1988 and 1989 cars can cause severe damage to the radiator and air conditioning lines at the front, and to the bumper and spoiler at the rear.

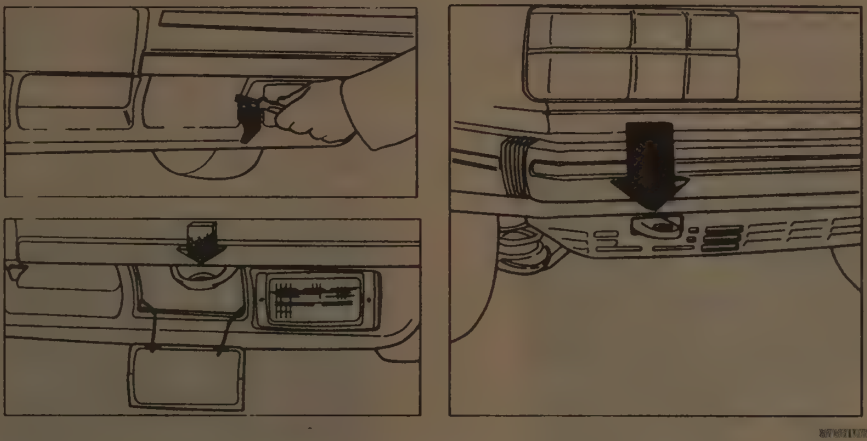


Fig. 97 Towing hooks are located at the front and rear of the car

JACKING

➧ See Figures 98, 99, 100 and 101

When raising the car with a floor jack, position the jack under the crossmember at the front of the car or under the differential case of the rear axle at the rear. When jacking at the front of the car, do not position the jack under the gravel shield or the engine oil pan, or you will damage these components.

➡If jacking the car on an incline or high up to a steep angle, block the opposing wheels to prevent the car from rolling.

NEVER crawl under a car supported only by a floor jack; use jackstands. Do not position the jackstands under lower control arms or other slanted surfaces as they might slip and allow the car to fall. The jackstands can be placed beneath the rear axle tubes at the rear of the car, and beneath the reinforced areas of the rocker panels or front frame members. The car's weight should push vertically (downward) on the stands; the stands should be on a level and solid base.

**CAUTION

Never use the tire changing jack to support the car when working underneath it. The car may fall, resulting in serious injury or death.

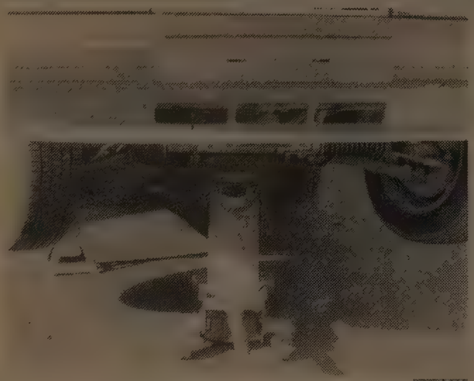


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Fig. 98 The crossmember at the front of the car allows both front wheels to be evenly lifted at once — don't forget to engage the parking brake and block the rear wheels before proceeding

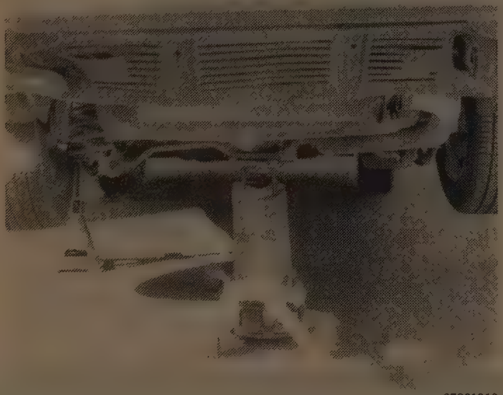

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Fig. 99 Center the floor jack under the rear differential to evenly lift the rear wheels — don't forget to block the front wheels before proceeding

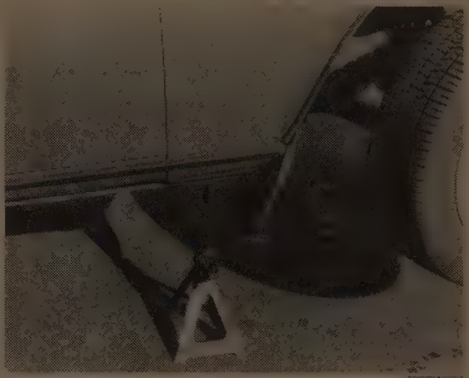

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Fig. 100 Use jackstands in an approved location such as under the reinforced area of the rocker panel — if the panels are severely rusted or damaged, find a sturdier place for the jackstands

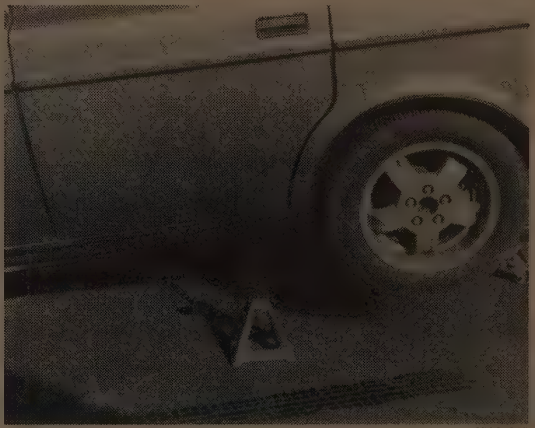

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Fig. 101 The rear of the rocker panel is also reinforced to allow jackstands to safely support the vehicle

Maintenance Intervals

In thousand of miles

Procedure	1970–74 Models	1975–83 Models	84–86 Models	87–89 Models
Engine				
Air filter change	24	30	30	30
Battery	6	7.5	7.5	7.5
Idle speed	12	15	30	30
Carb. oil level	6	7.5	—	—
Contact point adj.	6	7.5	—	—
Coolant replacement	12	30	30	30
Distributor lub., ck cap & rotor	6	15	30	30
Belt adj.	6	7.5	15	30
EGR valve replacement	24 ①	30	—	—
EGR system check	12 ①	15	—	—
Oxygen sen. replacement	—	15 ②	30 ⑧ ⑨	—
PCV system check & clean	12	15	20 ⑥	30
Evap canister replace	24	45	—	—
Ignition timing check	6	15	30	30
Fuel filter clean (carb)	6	—	—	—
Fuel filter replace (FI)	12	30 ③	30	30
Fuel tank pick-up screen cleaning	12	15	—	—
Spark plugs replace	12	15	30	30
Spark plugs cleaning	6	—	—	—
Oil change and filter replace	6	7.5 ⑤	7.5	7.5
Valve lash adj.	12	15	30 ⑦	60
Fuel filter draining (Diesel)	—	7.5	7.5	10
Fuel filter replacement (Diesel)	—	15	30	30
Body lubrication	6	7.5	7.5	7.5
Chassis				
Ball joints, steering rods check	12	7.5	7.5	7.5
Brake inspection	6	7.5	7.5	7.5
Driveshaft, U-joint check	6	7.5	7.5	7.5
Tire wear, align if nec.	6	7.5	7.5	15
Power steering fluid check	6	7.5	7.5	7.5
Rear axle fluid level-check	6	7.5	7.5	7.5
Manual trans. fluid-check	6	7.5	7.5	7.5
Auto. trans. fluid-check	6	7.5	7.5	7.5
Transmission oil change-auto	24	30 ④	22.5	22.5

① Not all models are equipped with an EGR valve
② 1980–83 models—30,000 miles
③ Electronic fuel injection—15,000 miles
④ Manual transmission only. No change needed on 1979–89 models
⑤ Turbo—3,750 miles
⑥ Clean flame guard
⑦ 84 & 85 diesel—15,000 miles.
⑧ Except B21A motor
⑨ For 85: 760 GLE only

85881C11

Capacities

Year	Model	Engine Displacement Cu In. (cc)	Engine Crankcase (qt)		Transmission (pts)		Drive Axle (pt)	Gasoline Tank (gal)	Cooling System (qt)
			With Filter	Without Filter	Manual 4 spd *	Automatic			
1970	142, 144, 145	122 (1990)	4.0	3.4	1.6 (3.4)	13.1	2.7	15.3	9.0
	164	183 (2978)	6.3	5.5	1.3 (3.0)	17.3	3.4	15.3	13.0
	1800	122 (1990)	4.0	3.4	①	—	2.7	12.0	9.0
1971	142, 144, 145	122 (1990)	4.0	3.4	1.6 (3.4)	13.1	2.7	15.3	10.5
	164	183 (2978)	6.3	5.5	1.3 (3.0)	17.3	3.4	15.3	13.0
	1800	122 (1990)	4.0	3.4	②	13.3	2.7	12.0	9.0
1972	142, 144, 145	122 (1990)	4.0	3.4	1.6 (3.4)	13.5	2.7	15.3	10.5
	164	183 (2978)	6.3	5.5	1.3 (3.0)	17.7	3.4	15.3	13.0
	1800	122 (1990)	4.0	3.4	②	13.5	2.7	12.0	9.0
1973	142, 144, 145	122 (1990)	4.0	3.4	1.6 (3.4)	13.5	2.7	15.3	10.5
	164	183 (2978)	6.3	5.5	1.3 (3.0)	17.7	3.4	15.3	13.0
	1800	122 (1990)	4.0	3.4	②	13.5	2.7	12.0	9.0
1974	142, 144, 145	122 (1990)	4.0	3.4	1.6 (3.4)	13.5	2.7	15.8	10.0
	164	183 (2978)	6.3	5.5	(3.1)	18.0	3.4	15.8	13.0
1975	242, 244, 245	122 (1990)	4.0	3.4	1.6 (3.4)	13.5	2.7	15.8	10.0
	164	183 (2978)	6.3	5.5	(3.1)	18.0	3.4	15.8	11.0
1976–77	242, 244, 245	130 (2127)	4.0	3.5	1.6 (4.8)	13.8	3.4	15.8	10.0
	262, 264, 265	162 (2660)	7.4	6.8	1.6 (4.8)	13.8	3.4	15.8	12.0
1978	242, 244, 245	130 (2127)	4.0	3.5	1.6 (3.8)	14.0	3.4	15.8	10.0
	262, 264, 265	162 (2660)	6.8	6.3	1.6 (4.8)	14.0	3.4	15.8	11.5
1979	242, 244, 245	130 (2127)	4.0	3.5	3.8	14.0 ④	3.4	15.8	10.0
	262, 264, 265	162 (2660)	6.8	6.3	4.8	14.0 ④	3.4	15.8	11.5
1980–83	DL, GL, GT ⑤	130 (2127)	4.0 ⑥	3.5 ⑥	4.8	14.6 ⑦	3.4	15.8	10.0
	GLE, Coupe	174 (2849)	6.8	6.3	4.8	14.6 ⑦	3.4	15.8	11.5
	DL, GL Diesel	145 (2383)	7.4	6.6	4.8	14.6 ⑦	3.4	15.8	10.0 ③
	DL, GL ⑬	140 (2320)	3.5	4.0	4.8	14.6 ⑦	3.4	15.8	10.0
	DL, GL Turbo	130 (2127)	4.0 ⑥	3.5 ⑥	4.8	14.6 ⑦	3.4	15.8	10.0
	760 GLE	174 (2849)	6.8	6.3	4.8	14.6 ⑦	3.4	15.8 ⑧	10.5
	760 GLE Turbo Diesel	145 (2383)	7.0	6.2	4.8	14.6 ⑦	3.4	15.8 ⑧	11.5 ⑨

87861C02

Capacities (cont.)

Year	Model	Engine Displacement Cu In. (cc)	Engine Crankcase (qt)		Transmission (pts)			Drive Axle (pts.)	Fuel Tank (gal.)	Cooling System (qts.)
			With Filter	Without Filter	4-Spd	5-Spd	Auto.			
1984	DL	140 (2320) B23F	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	DL	130 (2127) B21A ⑪	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	GL	140 (2320) B23F	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	Turbo	130 (2127) B21F-Turbo	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	Diesel	145 (2383) D24	7.4	6.6	4.8	—	15.6	⑩	15.8	10.0
	740 GLE	140 (2320) B23F ⑪	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	Turbo	130 (2127) B21F-Turbo	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	760 GLE	174 (2849) B28F	6.9	6.3	4.8	—	15.6	⑩	15.8	10.5
	Turbo	140 (2320) B23F-Turbo	4.1	3.6	4.8	—	15.6	⑩	15.8	10.0
	Turbo Diesel	145 (2383) D24-Turbo	6.3	5.2	4.8	—	15.6	⑩	15.8	11.5
1985	DL	140 (2320) B23F	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	DL	130 (2127) B21A ⑪	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	GL	140 (2320) B23F	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	Turbo	130 (2127) B21F-Turbo	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	Diesel	145 (2383) D24	7.4	6.6	4.8	—	15.6	⑩	15.8	10.0
	740 GLE	140 (2320) B230F	4.1	3.6	4.8	—	15.6	⑩	15.8	10.0
	Turbo	140 (2320) B230F-Turbo	4.1 ⑫	3.6 ⑫	4.8	—	15.6	⑩	15.8	10.0
	Turbo Diesel	145 (2383) D24-Turbo	6.3	5.2	4.8	—	15.6	⑩	15.8	11.5
	760 GLE	174 (2849) B28F	6.9	6.3	4.8	—	15.6	⑩	15.8	10.5
	Turbo	140 (2320) B230F-Turbo	4.1 ⑫	3.6 ⑫	4.8	—	15.6	⑩	15.8	10.0
	GLE TD	145 (2383) D24-Turbo	6.3	5.2	4.8	—	15.6	⑩	15.8	11.5
1986	240 DL	140 (2320) B230F	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	GL	140 (2320) B230F	4.0	3.5	4.8	—	15.6	⑩	15.8	10.0
	740 GL	140 (2320) B230F	4.1	3.6	4.8	—	15.6	⑩	15.8	10.0
	GLE	140 (2320) B230F	4.1	3.6	4.8	—	15.6	⑩	15.8	10.0
	Turbo	140 (2320) B230F-Turbo	4.1 ⑫	3.6 ⑫	4.8	—	15.6	⑩	15.8	10.0
	GLE TD	145 (2383) D24-Turbo	6.3	5.2	4.8	—	15.6	⑩	15.8	11.5
	760 GLE	174 (2849) B28F	6.9	6.3	4.8	—	15.6	⑩	15.8	10.5
	Turbo	140 (2320) B230F-Turbo	4.1 ⑫	3.6 ⑫	4.8	—	15.6	⑩	15.8	10.0
	GLE TD	145 (2383) D24-Turbo	6.3	5.2	4.8	—	15.6	⑩	15.8	11.5

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Capacities (cont.)

Year	Model	Engine Displacement Cu In. (cc)	Engine Crankcase (qt)		Transmission (pts)			Drive Axle (pts.)	Fuel Tank (gal.)	Cooling System (qts.)
			With Filter	Without Filter	4-Spd	5-Spd	Auto.			
1987	240 DL	140 (2320) B230F	4.0	3.5	—	2.8	15.6	⑩	15.8	10.0
	GL	140 (2320) B230F	4.0	3.5	—	2.8	15.6	⑩	15.8	10.0
	740 GL	140 (2320) B230F	4.1	3.6	4.8	—	15.6	⑩	15.8	10.0
	GLE	140 (2320) B230F	4.1	3.6	4.8	—	15.6	⑩	15.8	10.0
	Turbo	140 (2320) B230F-Turbo	4.1 ⑫	3.6 ⑫	4.8	—	15.6	⑩	15.8	10.0
	760 GLE	174 (2849) B280F	6.3	5.8	4.8	—	15.8	⑩	15.8	10.5
	Turbo	140 (2320) B230F-Turbo	4.1 ⑫	3.6 ⑫	4.8	—	15.8	⑩	15.8	10.0
	780	174 (2849) B280F	6.3	5.8	4.8	—	15.8	⑩	15.8	10.5
1988–89	240 DL	140 (2320) B230F	4.0	3.5	—	3.2	15.8	⑩	15.8	10.0
	GL	140 (2320) B230F	4.0	3.5	—	3.2	15.8	⑩	15.8	10.0
	740 GL	140 (2320) B230F	4.1	3.6	—	3.2	15.8	⑩	15.8	10.0
	GLE ⑭	140 (2320) B230F	4.1	3.6	—	3.2	15.8	⑩	15.8	10.0
	GLE ⑮	140 (2320) B234F	4.1	3.6	—	3.2	15.8	⑩	15.8	10.0
	Turbo	140 (2320) B230F-Turbo	4.1 ⑫	3.6 ⑫	—	4.8	15.8	⑩	15.8	10.0
	760 GLE	174 (2849) B280F	6.3	5.8	—	—	15.8	⑩	21.1	10.5
	Turbo	140 (2320) B230F-Turbo	4.1 ⑫	3.6 ⑫	—	—	15.8	⑩	21.1	10.0
	780	174 (2849) B280F	6.3	5.8	—	—	15.8	⑩	21.1	10.5

*Figures in parentheses are for overdrive transmissions

① M400 trans. : 1.3 pts.
M410 trans. : 3.0 pts.
M40 trans. : 1.6 pts.
M41 trans. : 3.4 pts.
② M40 trans. : 1.6 pts.
M41 trans. : 3.4 pts.
③ 9.8 qts w/auto trans
④ With extra capacity fluid pan: 14.6
⑤ 1980-82 models
⑥ Cars w/turb: if oil cooler is drained, add 0.7 qt.
⑦ AW70 and AW71 (1982 and later 4-speed) 15.6 pts.
⑧ With increased capacity tank 21.6 gal.
⑨ With auto. trans. 10.5 qt.
⑩ 1030 axle: 2.8 pts.
1031 axle: 3.4 pts.
⑪ Canada only
⑫ Models w/turbo: add 0.6 qt. if oil cooler has been drained
⑬ 1983 model
⑭ 1988 model
⑮ 1989 model

87861C04

2

ENGINE PERFORMANCE AND TUNE-UP

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IDLE SPEED AND MIXTURE ADJUSTMENTS 2-20
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TUNE-UP PROCEDURES

➧ See Figure 1

The procedures listed here are intended to be specific. If there is something wrong with your engine (for example: a misfire, stumbling idle, etc.) turn to the troubleshooting chart. The chart gives step-by-step tests which can isolate your engine's problem quickly.

➡1970-74 Volvos are equipped with breaker point ignition systems. 1975 and later non-diesel Volvos have electronic ignition systems.

Neither tune-up nor troubleshooting can be considered independently, since each has a direct bearing on the other. An engine tune-up is a service designed to restore the maximum power, performance, economy and reliability in an engine and, at the same time, assure the owner of efficiency and trouble-free performance. Engine tune-up becomes increasingly important each year, to insure that pollutant levels are in compliance with federal emissions standards.

It is advisable to follow a definite and thorough tune-up procedure. Tune-up consists of three separate steps: Analysis, the process of determining whether normal wear is responsible for performance loss, and whether the parts require replacement or service; Parts Replacement, the removal of worn or failed mechanical parts, and Service/Adjustment, during which parts may be cleaned, reset, or tightened and factory specifications are maintained or adjusted.

The extent of an engine tune-up is usually determined by the length of time since the previous service, although the type of driving and the general mechanical condition of the engine must be considered. Specific maintenance should also be performed at regular intervals, depending on operating conditions.

Troubleshooting is a logical sequence of procedures designed to lead you to the particular cause of trouble. The troubleshooting section of this manual is general in nature, yet specific enough to locate the problem. Service usually comprises two areas, diagnosis and repair. While the apparent cause of trouble, in many cases, is worn or damaged parts, performance problems are less obvious. The first job is to locate the problem and cause. Once the problem has been isolated, refer to the appropriate section for repair, removal or adjustment procedures.

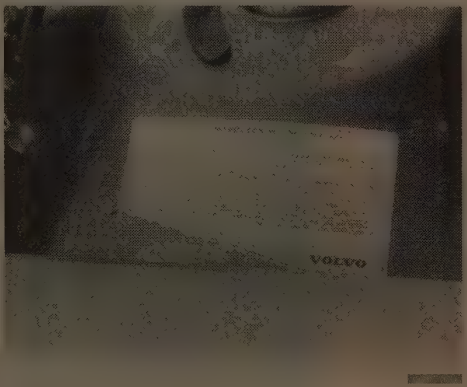


Fig. 1 Information needed for a tune-up may be found on a label mounted on one of the shock absorber towers. If you have conflicting information, always defer to the label

It is advisable to read the entire section before beginning a tune-up, although those who are more familiar with tune-up procedures may wish to go directly to the instructions.

Spark Plugs

➧ See Figures 2 and 3

A typical spark plug consists of a metal shell surrounding a ceramic insulator. A metal electrode extends downward through the center of the insulator and protrudes a small distance at the bottom. Located at the end of the plug and attached to the side of the outer metal shell is the side electrode. The side electrode bends in at a 90 degree angle so that its tip is even with, and parallel to, the tip of the center electrode. The distance between these two electrodes (measured in thousandths of an inch or in millimeters) is called the spark plug gap. The spark plug in no way produces a spark but merely provides a gap across which the current can arc. The coil produces anywhere from 20,000-40,000 volts. This electric charge passes to the distributor which then sends the charge through each spark plug wire to the plug itself. The current passes along the center electrode and jumps the gap to the side electrode, and in so doing, ignites the air/fuel mixture in the combustion chamber.

Spark plug life and efficiency depend upon the condition of the engine and the temperature to which the plug is exposed. Combustion chamber temperatures are affected by many factors such as compression ratio of the engine, air/fuel mixtures, exhaust emission equipment and the type of driving you do. Spark plugs are designed and classified by number according to the heat range at which they will operate most efficiently.

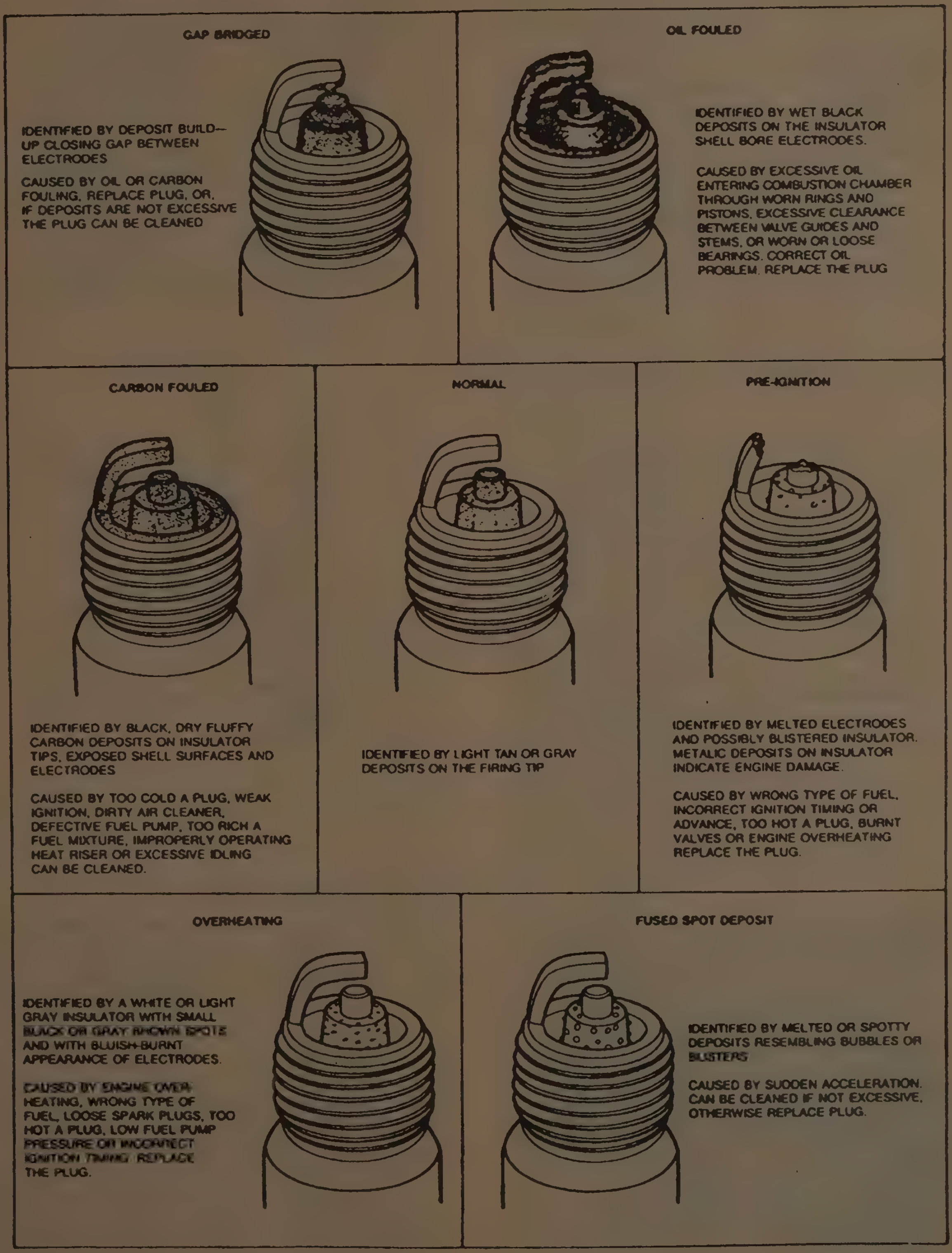
HEAT RANGE

➧ See Figure 4

While spark plug heat range has always seemed to be somewhat of a mystical subject for many people, in reality the subject is quite simple. Basically, it boils down to this: the amount of heat the plug absorbs is determined by the length of the lower insulator. The longer the insulator (or the farther it extends into the engine), the hotter the plug will operate. A shorter insulator operates cooler.

A plug that absorbs little heat and remains too cool will quickly accumulate deposits of oil and carbon since it is not hot enough to burn them off. This leads to plug fouling and consequently to misfiring. A plug that absorbs too much heat will have no deposits, but, due to the excessive heat, the electrodes will burn away quickly and in some instances, preignition (pinging) may result. Preignition takes place when plug tips get so hot that they glow sufficiently to ignite the fuel/air mixture before the actual spark occurs.

This early ignition will usually cause a pinging during low speed operation or under heavy loads such as accelerating up a hill. In severe cases, the heat may become high enough to



GAP BRIDGED

IDENTIFIED BY DEPOSIT BUILD-UP CLOSING GAP BETWEEN ELECTRODES

CAUSED BY OIL OR CARBON FOULING. REPLACE PLUG, OR, IF DEPOSITS ARE NOT EXCESSIVE THE PLUG CAN BE CLEANED

OIL FOULED

IDENTIFIED BY WET BLACK DEPOSITS ON THE INSULATOR SHELL BORE ELECTRODES.

CAUSED BY EXCESSIVE OIL ENTERING COMBUSTION CHAMBER THROUGH WORN RINGS AND PISTONS, EXCESSIVE CLEARANCE BETWEEN VALVE GUIDES AND STEMS, OR WORN OR LOOSE BEARINGS. CORRECT OIL PROBLEM. REPLACE THE PLUG

CARBON FOULED

IDENTIFIED BY BLACK, DRY FLUFFY CARBON DEPOSITS ON INSULATOR TIPS, EXPOSED SHELL SURFACES AND ELECTRODES

CAUSED BY TOO COLD A PLUG, WEAK IGNITION, DIRTY AIR CLEANER, DEFECTIVE FUEL PUMP, TOO RICH A FUEL MIXTURE, IMPROPERLY OPERATING HEAT RISER OR EXCESSIVE IDLING CAN BE CLEANED.

NORMAL

IDENTIFIED BY LIGHT TAN OR GRAY DEPOSITS ON THE FIRING TIP

PRE-IGNITION

IDENTIFIED BY MELTED ELECTRODES AND POSSIBLY BLISTERED INSULATOR. METALIC DEPOSITS ON INSULATOR INDICATE ENGINE DAMAGE.

CAUSED BY WRONG TYPE OF FUEL, INCORRECT IGNITION TIMING OR ADVANCE, TOO HOT A PLUG, BURNT VALVES OR ENGINE OVERHEATING REPLACE THE PLUG.

OVERHEATING

IDENTIFIED BY A WHITE OR LIGHT GRAY INSULATOR WITH SMALL BLACK OR GRAY BROWN SPOTS AND WITH BLUISH-BURNT APPEARANCE OF ELECTRODES.

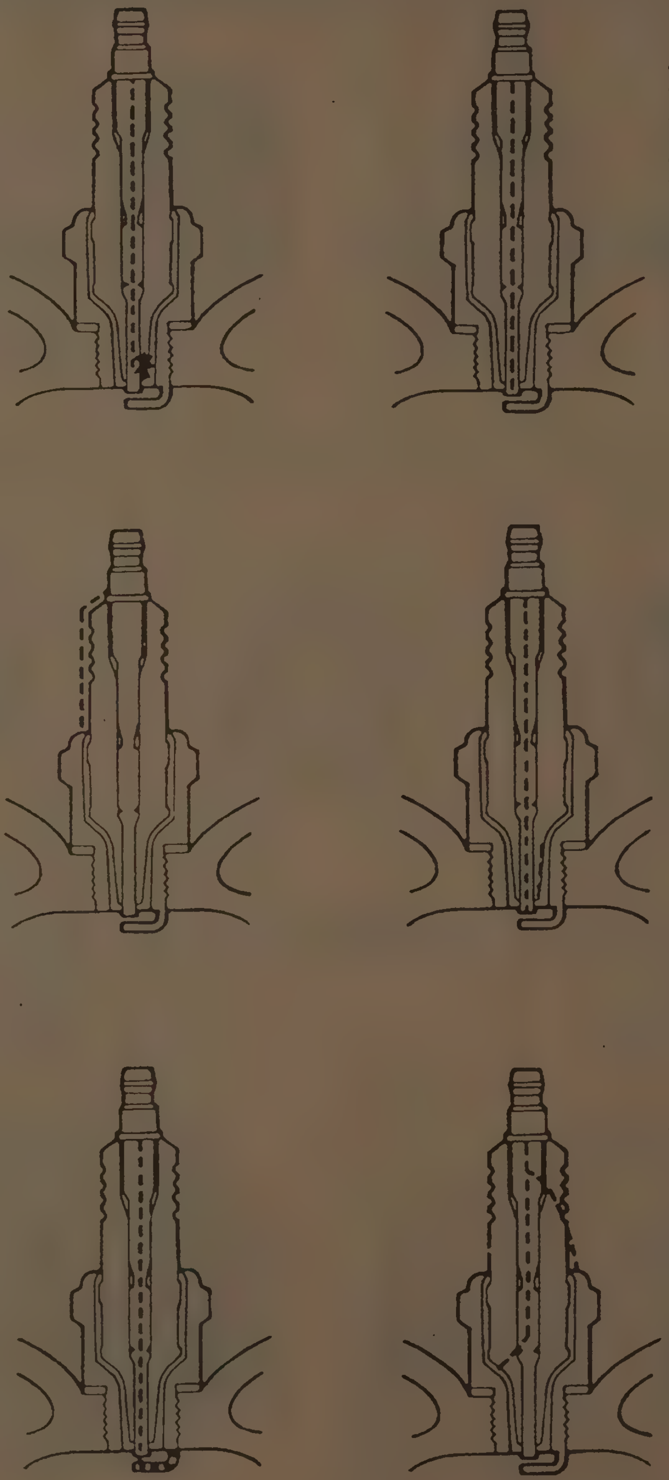
CAUSED BY ENGINE OVER-HEATING, WRONG TYPE OF FUEL, LOOSE SPARK PLUGS, TOO HOT A PLUG, LOW FUEL PUMP PRESSURE OR INCORRECT IGNITION TIMING. REPLACE THE PLUG.

FUSED SPOT DEPOSIT

IDENTIFIED BY MELTED OR SPOTTY DEPOSITS RESEMBLING BUBBLES OR BLISTERS

CAUSED BY SUDDEN ACCELERATION. CAN BE CLEANED IF NOT EXCESSIVE, OTHERWISE REPLACE PLUG.

Fig. 2 Inspect the spark plugs to determine engine running conditions



Tracking Arc
High voltage arcs between a fouling deposit on the insulator tip and spark plug shell. This ignites the fuel/air mixture at some point along the insulator tip, retarding the ignition timing which causes a power and fuel loss.

Wide Gap
Spark plug electrodes are worn so that the high voltage charge cannot arc across the electrodes. Improper gapping of electrodes on new or "cleaned" spark plugs could cause a similar condition. Fuel remains unburned and a power loss results.

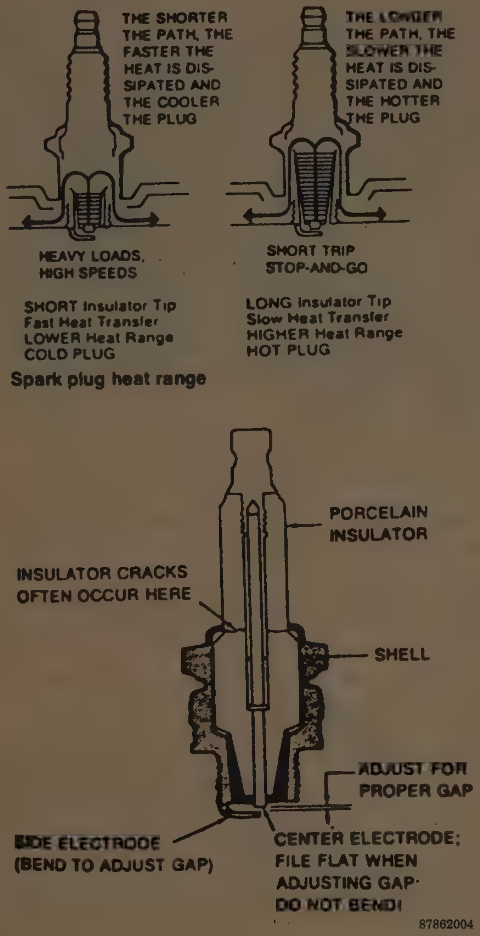
Flashover
A damaged spark plug boot, along with dirt and moisture, could permit the high voltage charge to short over the insulator to the spark plug shell or the engine. A buttress insulator design helps prevent high voltage flashover.

Fouled Spark Plug
Deposits that have formed on the insulator tip may become conductive and provide a "shunt" path to the shell. This prevents the high voltage from arcing between the electrodes. A power and fuel loss is the result.

Bridged Electrodes
Fouling deposits between the electrodes "ground out" the high voltage needed to fire the spark plug. The arc between the electrodes does not occur and the fuel air mixture is not ignited. This causes a power loss and exhausting of raw fuel.

Cracked Insulator
A crack in the spark plug insulator could cause the high voltage charge to "ground out." Here, the spark does not jump the electrode gap and the fuel air mixture is not ignited. This causes a power loss and raw fuel is exhausted.

Fig. 3 Used spark plugs which show damage may indicate engine problems


THE SHORTER THE PATH, THE FASTER THE HEAT IS DISSIPATED AND THE COOLER THE PLUG
THE LONGER THE PATH, THE SLOWER THE HEAT IS DISSIPATED AND THE HOTTER THE PLUG
HEAVY LOADS, HIGH SPEEDS
SHORT TRIP STOP-AND-GO
SHORT Insulator Tip
Fast Heat Transfer
LOWER Heat Range
COLD PLUG
LONG Insulator Tip
Slow Heat Transfer
HIGHER Heat Range
HOT PLUG
PORCELAIN INSULATOR
INSULATOR CRACKS OFTEN OCCUR HERE
SHELL
ADJUST FOR PROPER GAP
SIDE ELECTRODE (BEND TO ADJUST GAP)
CENTER ELECTRODE: FILE FLAT WHEN ADJUSTING GAP· DO NOT BEND!
87862004

Spark plug heat range

Fig. 4 Cross-sectional view of common-style hot and cold spark plugs

start the fuel/air mixture burning throughout the cylinder, rather than just in front of the plug as is normal. The burning mass is compressed and a premature explosion results, forcing the piston back down in the cylinder while it is still trying to go up. Obviously, this is not a healthy situation for the piston — quite frequently pistons are severely damaged. For this reason, severe or continuous preignition should never be ignored.

The general rule of thumb for choosing the correct spark plug heat range is that if most of your driving is long distance or high speed travel, use a colder plug; if most of your driving is stop and go,or low speed travel, use a hotter plug. Factory-installed plugs are, of course, a compromise, since the factory has no way of knowing what sort of driving you do. It should be noted that most people never have occasion to change their plugs from the factory-recommended heat range. If you wish to use an alternate plug, consult the emissions label under the hood of cars from 1978 to the present; it will give you the recommended standard plug and the recommended alternate (generally colder) plug description.

REMOVAL & INSTALLATION

➧ See Figures 5, 6, 7, 8 and 9

Every six months or 6,000 miles (9662 km), the spark plugs should be removed for inspection on older cars. At this time they should be cleaned and regapped. At 12 month/12,000 mile (19,324 km) intervals on 1973-74 models and at 12 month/15,000 mile (24,155 km) intervals on 1975 and later models, the plugs should be replaced. Although Volvo recommends replacing the plugs at 30,000 miles (48,309 km) on 1984 and later vehicles, it should be noted that this is a maximum interval. For some owners, 30,000 miles (48,309 km) represents more than three years of driving. A prudent owner will remove and check or replace the plugs more frequently. Even if they are not heavily worn, a new set will improve performance.

➡Remove and install spark plugs only when the engine is cold; this is particularly important on engines with aluminum heads.

Remove each spark plug wire by grasping its metal or rubber boot at the end and twisting slightly to free the wire from the plug. Using a spark plug socket, turn the plugs counterclockwise to remove them. Do not allow any foreign matter to enter the cylinders through the spark plugs holes.

The gap must be checked with a wire gauge before installing the plug in the engine. With the ground electrode positioned parallel to the center electrode, the specified wire gauge must pass through the opening with a slight drag. If the air gap between the two electrodes is not correct, the ground electrode must be bent to bring it to specifications.

After the plugs are gapped correctly, they may be inserted into their holes and hand-tightened. Be careful not to cross-thread the plugs. After each plug is hand threaded several turns, it may be tightened with the wrench: DO NOT OVERTIGHTEN SPARK PLUGS. Correct torque is 15-18 ft. lbs (20-24 Nm) except B28 and B280 engines which require only 9 ft. lbs. (12 Nm). Overtightening a spark plug can become a very costly problem if you damage the cylinder head. Install each spark plug wire on its respective plug, making sure that

Fig. 5 Initially pull only on the boot, not the wire, when removing the boot from the spark plug

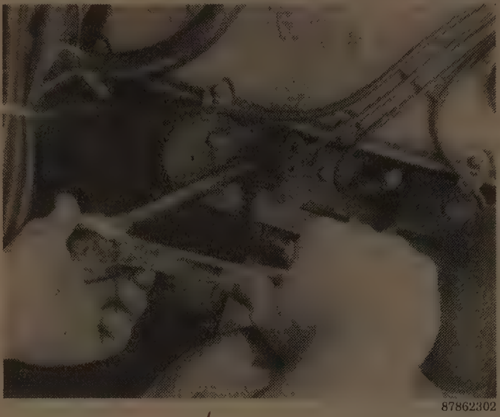


Fig. 6 Using a spark plug socket and ratchet with extension, carefully turn counterclockwise to remove the plug

Fig. 7 Do not allow any debris into the spark plug holes

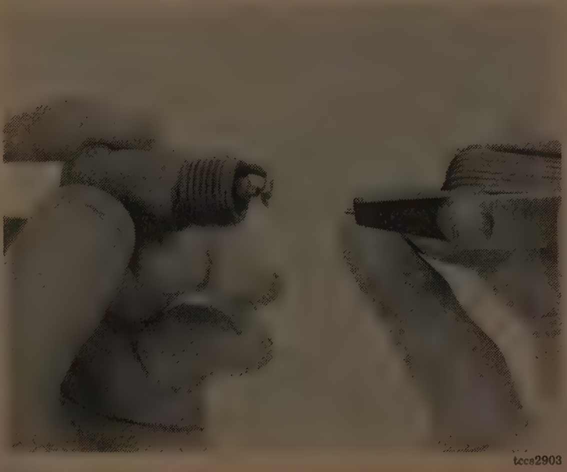


Fig. 8 Checking the spark plug gap with a feeler gauge

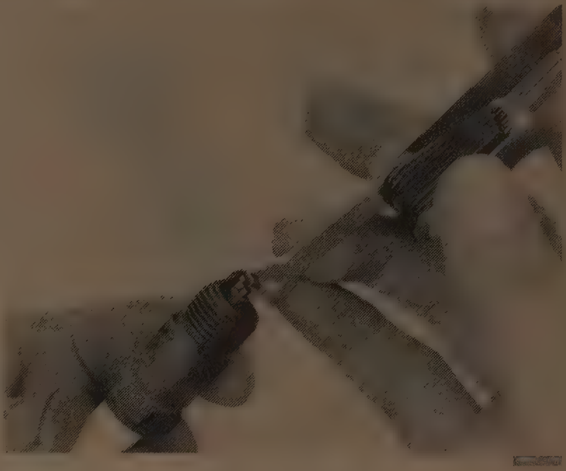


Fig. 9 Adjusting the spark plug gap

each spark plug end is making good metal-to-metal contact in its wire socket.

CHECKING AND REPLACING SPARK PLUG WIRES

➧ See Figures 10 and 11

Visually inspect the spark plug wires for burns, cuts, or breaks in the insulation. Check the spark plug boots and the nipples on the distributor cap and coil. Replace any damaged wiring. If no physical damage is obvious, the wires can be checked with an ohmmeter for excessive resistance. Remove the distributor cap and leave the wires connected to the cap. Connect one lead of the ohmmeter to the corresponding electrode inside the cap and the other lead to the spark plug terminal (remove it from the spark plug for the test). Replace any wire which shows over 50,000 ohms. Generally speaking, resistance should not run over 35,000 ohms and 50,000 ohms should be considered the outer limits of acceptability.

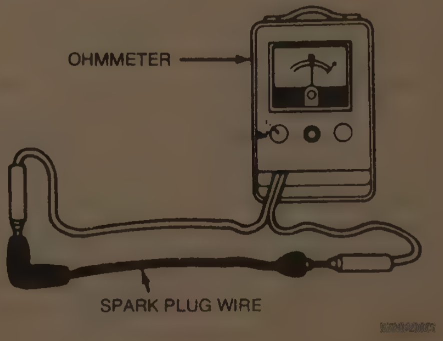


Fig. 10 Use an ohmmeter to check spark plug wire resistance

Fig. 11 Check the spark plug boots and the nipples on the distributor cap and coil

Test the coil wire by connecting the ohmmeter between the center contact in the cap and either of the primary terminals at the coil. If the total resistance of the coil and wire is more than 25,000 ohms, remove the wire from the coil and check the resistance of the wire alone. If the resistance is higher than 15,000 ohms, replace the wire. It should be remembered that wire resistance is a function of length, and that the longer the wire, the greater the resistance. Thus, if the wires on your car are longer than the factory originals, resistance will be higher and quite possibly outside of these limits.

When installing a new set of spark plug wires, replace the wires one at a time so there will be no mix-up. Start by replacing the longest wire first. Install the boot firmly over the spark plug. Route the wire exactly the same as the original. Insert the nipple firmly into the tower on the distributor cap. Repeat the process for each wire.

Firing Orders

▸ See Figures 12, 13, 14, 15 and 16

➡To avoid confusion when replacing wires, remove and tag them one at a time.

Breaker Points and Condenser

REPLACEMENT

1970-74 Models and Canadian B21A Engine

▸ See Figure 17

Volvo recommends that the breaker points be inspected and adjusted every six months or 6000 miles (9662 km). If, upon inspection, the points prove to be faulty, they must be replaced with the condenser as unit.

****CAUTION**

Make sure the ignition is OFF.

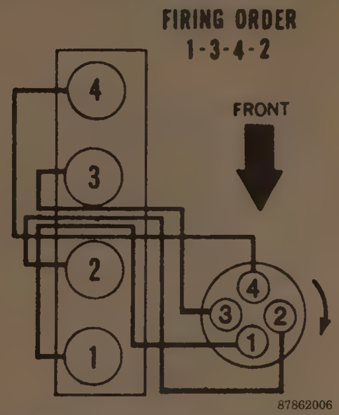


Fig. 12 B21F, B23 and B230 series engines
Engine Firing Order: 1-3-4-2
Distributor rotation: clockwise

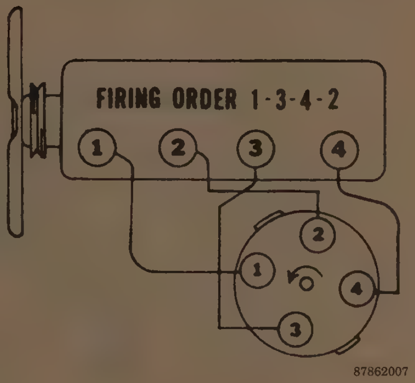


Fig. 13 B20 engine
Engine Firing Order: 1-3-4-2
Distributor rotation: counterclockwise

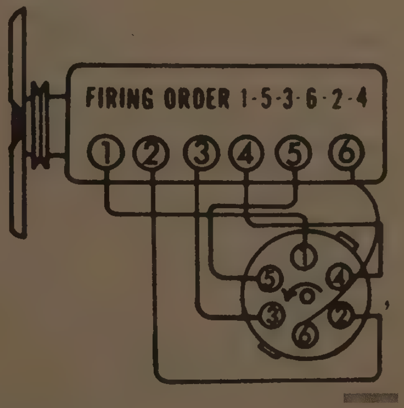


Fig. 14 B30 engine
Engine Firing Order: 1-5-3-6-2-4
Distributor rotation: counterclockwise

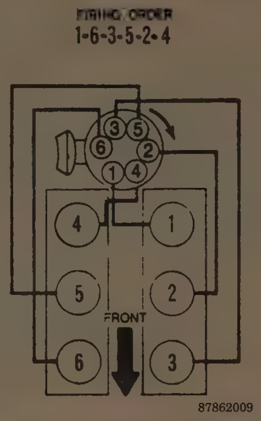


Fig. 15 B27, B28 and BZ80 series engines
Engine Firing Order: 1-6-3-5-2-4
Distributor rotation: clockwise

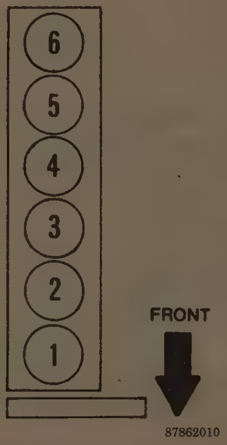


Fig. 16 D24 and D24T diesel engines
Engine Firing Order: 1-5-3-6-2-4

Remove the distributor cap and rotor from the top of the distributor, taking note of their placement. On fuel-injected six-cylinder models, remove the breaker point protective cover. Place a screwdriver against the breaker points and examine the condition of the contacts. Replace the points if the contacts are blackened, pitted, or worn excessively, if the breaker arm has lost its tension, or if the fiber rubbing block on the breaker has become worn or loose. Contact points that have become slightly burned (light gray) may be cleaned with a point file.

To replace the points and condenser, disconnect the electrical leads for both at the primary connection. Remove the lockscrew for the contact breakers and lift them straight up. Loosen the condenser bracket retaining screw and slide out the condenser. While the points are out, lubricate the breaker cam with a very light coating of silicone-based grease. Clean the distributor base plate with alcohol to free it of any oil film that might impede completion of the ground circuit. Also clean the contact point surfaces with the solvent. Install the new points and new condenser and tighten their retaining screws. Connect the electrical leads for both at the primary connection. Make sure that the point contacts are aligned horizontally and vertically. If the points are not aligned properly, bend the stationary arm as necessary.

The breaker points must be correctly gapped before proceeding any further. Turn the engine until the rubbing block on the point assembly is resting on the high point of the distributor cam. Loosen the hold-down screw lightly and insert a feeler gauge of the proper thickness between the point contacts. Fine adjustment is made by inserting a screwdriver into the adjusting recess and turning the screwdriver until the proper size feeler gauge passes between the point contacts with a slight drag. Without disturbing the setting, tighten the breaker point retaining screw.

If a dwell meter is available, proceed to Dwell Angle Adjustment. A dwell meter is considered a more accurate means of measuring point gap. If the meter is not available, except on fuel-injected six-cylinder models, proceed to replace the rotor on top of the distributor shaft, making sure that the tab inside the rotor aligns with the slot on the distributor. Before replacing the rotor on fuel-injected six-cylinder models, install the breaker point protective cover. Place the distributor cap on top of the distributor, make sure it is properly seated, and snap the cap clasps into the slots on the cap. Make sure that all the spark plug wires fit snugly into the cap. Proceed to the Ignition Timing Adjustment.

DWELL ANGLE

➡It is not possible to set the dwell on electronic ignition systems, although it is possible to measure it.

Adjustment

1970-74 MODELS AND CANADIAN B21A ENGINES

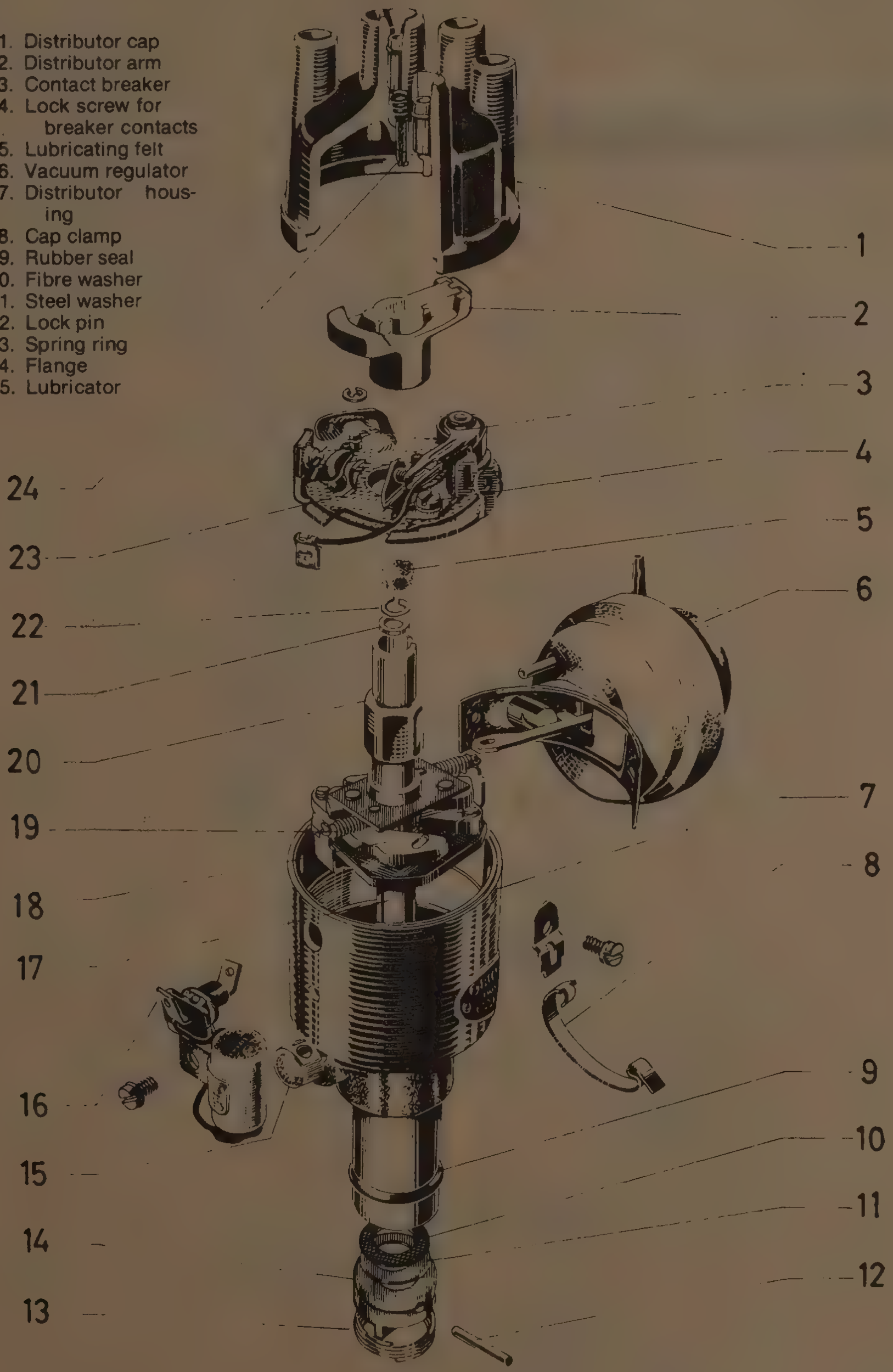
The dwell angle is the number of degrees of distributor cam rotation through which the breaker points remain fully closed (conducting electricity). Increasing the point gap decreases dwell, while decreasing the point gap increases dwell.

Using a dwell meter, connect the red lead (positive) of the meter to the distributor primary wire connection on the positive (+) side of the coil, and the black lead (negative) wire of the meter to a good ground on the engine (such as a thermostat housing nut).

The dwell angle may be checked either with the distributor cap and rotor installed and the engine running, or with the cap and rotor removed and the engine cranking at starter speed. The meter gives a constant reading with the engine running. With the engine cranking, the reading will fluctuate between zero degrees dwell and the maximum figure for that angle. While cranking, the maximum figure is the correct one for that setting. Never attempt to change dwell angle while the ignition is **ON**; touching the point contacts or wire connection with a metal screwdriver while the ignition is **ON** may result in a nasty shock.

To change the dwell angle, loosen the point retaining screw slightly and make the approximate correction. Tighten the retaining screw, then test the dwell with the engine cranking. If the dwell appears to be correct, install the breaker point protective cover, if so equipped, the rotor and distributor cap, and test the dwell with the engine running. Take the engine through its entire rpm range and observe the dwell meter. The

1. Distributor cap
2. Distributor arm
3. Contact breaker
4. Lock screw for breaker contacts
5. Lubricating felt
6. Vacuum regulator
7. Distributor housing
8. Cap clamp
9. Rubber seal
10. Fibre washer
11. Steel washer
12. Lock pin
13. Spring ring
14. Flange
15. Lubricator



16. Primary connection
17. Distributor shaft
18. Centrifugal weight
19. Centrifugal governor spring
20. Breaker cam
21. Washer
22. Circlip
23. Breaker plate
24. Rod brush (carbon)

Fig. 17 Exploded view of a common breaker point distributor — 6-cylinder engines

dwell should remain within specifications at all times. Great fluctuation of dwell at different engine speeds indicates worn distributor parts.

Following the dwell angle adjustment, the ignition timing must be checked. A 1° increase in dwell results in the ignition timing being retarded 2° and vice versa.

Electronic Ignition

1975 AND LATER MODELS

➧ **See Figures 18, 19 and 20**

There are two major differences from the point type systems: First, the points and condenser are replaced by an induction type impulse sender. Second, an electronic module has been added to amplify the electrical impulses between the distributor and coil. The impulse sender is located inside the distributor where the points used to be. Instead of opening and closing an electrical circuit, the sender opens and closes a magnetic circuit. This induces impulses in a magnetic pick-up. The sender consists of a stator, pick-up, rotor, and permanent magnet. The stator and armature each have the same number of teeth as there are cylinders. The permanent magnet creates a magnetic field which goes through the stator. The circuit is closed when the teeth are opposite each other. This means that the rotor opens and closes the magnetic field while rotating. This generates current pulses in the magnetic pick-up.

The electronic module is a solid state design which is fully transistorized. It amplifies the impulses from the sender and controls the dwell angle.

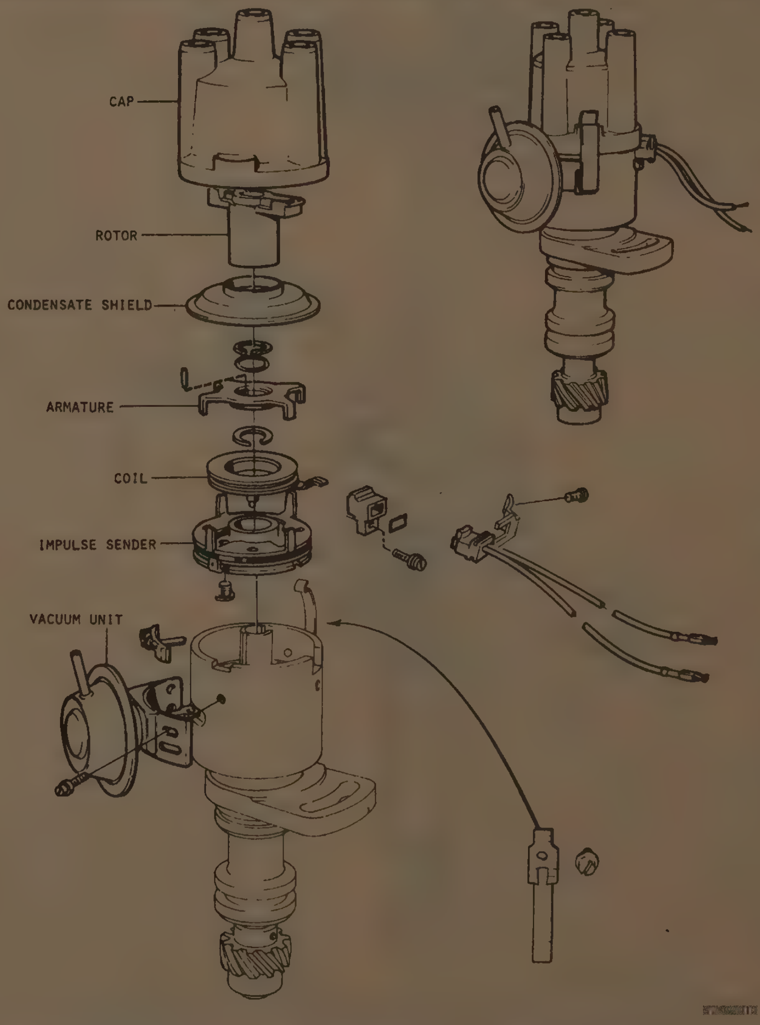


Fig. 18 Exploded view of a common electronic ignition distributor — 4-cylinder engines

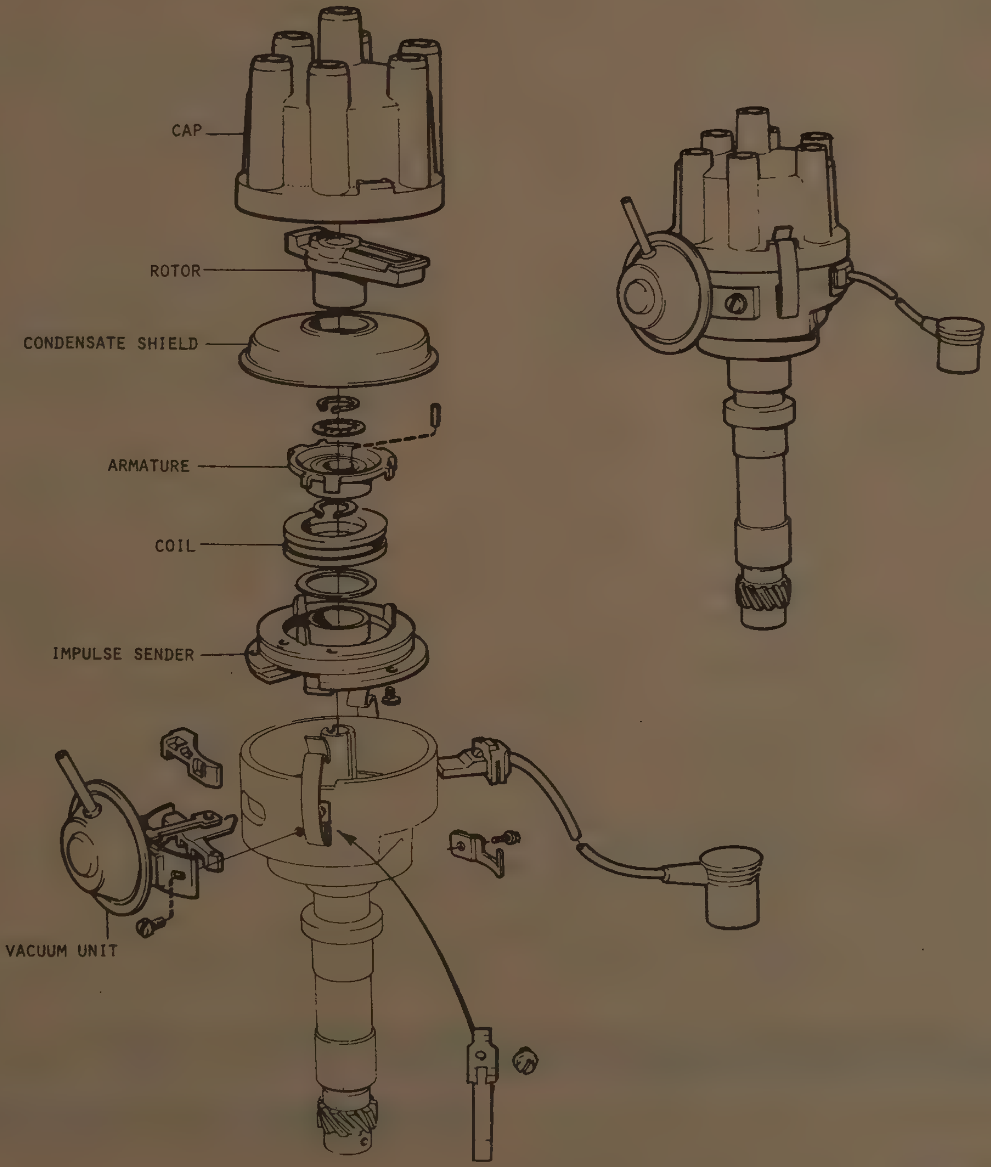
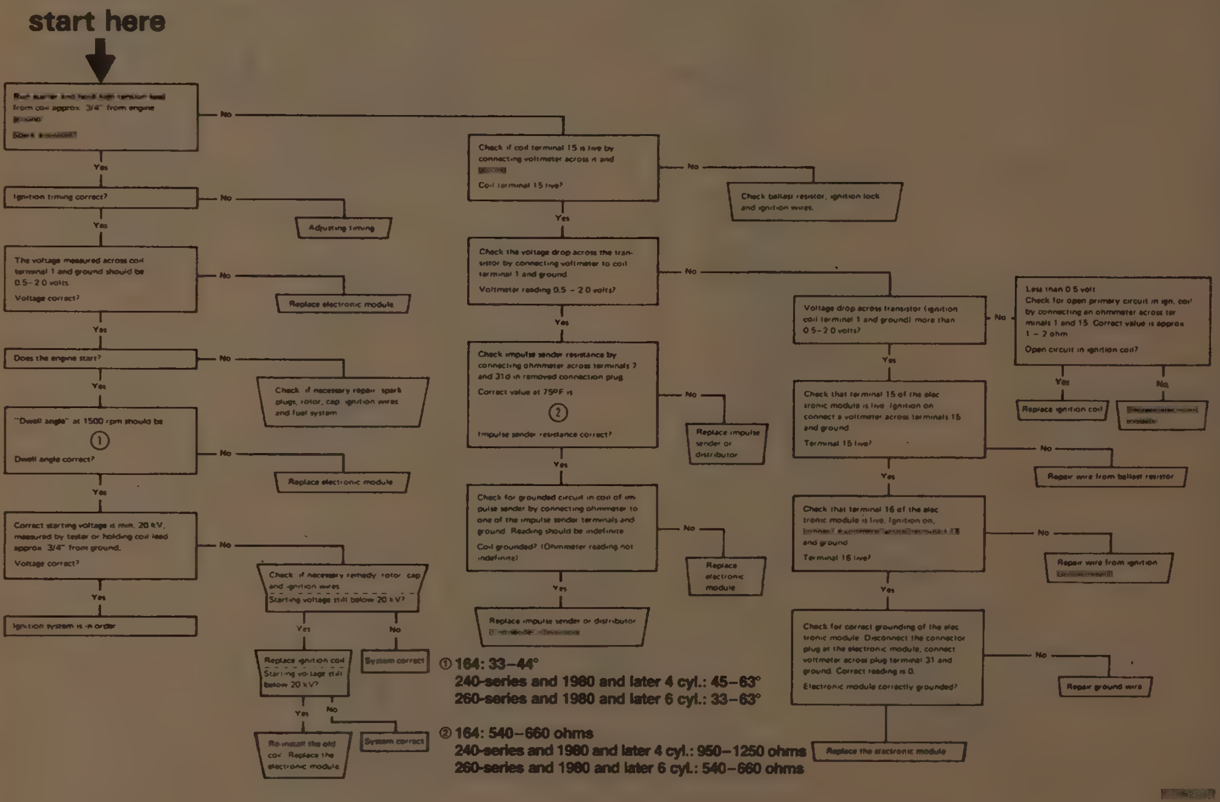

CAP
ROTOR
CONDENSATE SHIELD
ARMATURE
COIL
IMPULSE SENDER
VACUUM UNIT

Fig. 19 Exploded view of a common electronic ignition distributor — 6-cylinder engines


start here
Run starter and hold high tension lead from coil approx. 3/4" from engine ground.
Spark present?
No
Yes
Ignition timing correct?
No
Adjusting timing
Yes
The voltage measured across coil terminal 1 and ground should be 0.5–2.0 volts.
Voltage correct?
No
Replace electronic module
Yes
Does the engine start?
No
Check, if necessary repair, spark plugs, rotor, cap, ignition wires and fuel system
Yes
"Dwell angle" at 1500 rpm should be ①
Dwell angle correct?
No
Replace electronic module
Yes
Correct starting voltage is min. 20 kV, measured by tester or holding coil lead approx. 3/4" from ground.
Voltage correct?
No
Check, if necessary remedy rotor, cap and ignition wires
Starting voltage still below 20 kV?
Yes
No
Replace ignition coil
Starting voltage still below 20 kV?
System correct
Yes
No
Re-install the old coil. Replace the electronic module
System correct
Yes
Ignition system is in order
Check if coil terminal 15 is live by connecting voltmeter across it and ground.
Coil terminal 15 live?
No
Check ballast resistor, ignition lock and ignition wires.
Yes
Check the voltage drop across the transistor by connecting voltmeter to coil terminal 1 and ground.
Voltmeter reading 0.5 – 2.0 volts?
No
Yes
Check impulse sender resistance by connecting ohmmeter across terminals 7 and 31d in removed connection plug.
Correct value at 75ºF is ②
Impulse sender resistance correct?
No
Replace impulse sender or distributor
Yes
Check for grounded circuit in coil of impulse sender by connecting ohmmeter to one of the impulse sender terminals and ground. Reading should be indefinite.
Coil grounded? (Ohmmeter reading not indefinite)
No
Replace electronic module
Yes
Replace impulse sender or distributor
[illegible]
Voltage drop across transistor (ignition coil terminal 1 and ground) more than 0.5–2.0 volts?
No
Less than 0.5 volt
Check for open primary circuit in ign. coil by connecting an ohmmeter across terminals 1 and 15. Correct value is approx. 1 – 2 ohm.
Open circuit in ignition coil?
Yes
Replace ignition coil
No
Replace electronic module
Yes
Check that terminal 15 of the electronic module is live. Ignition on, connect a voltmeter across terminals 15 and ground.
Terminal 15 live?
No
Repair wire from ballast resistor
Yes
Check that terminal 16 of the electronic module is live. Ignition on, connect a voltmeter across terminal 16 and ground.
Terminal 16 live?
No
Repair wire from ignition coil terminal 1
Yes
Check for correct grounding of the electronic module. Disconnect the connector plug at the electronic module, connect voltmeter across plug terminal 31 and ground. Correct reading is 0.
Electronic module correctly grounded?
No
Repair ground wire
Replace the electronic module
87082G14

① 164: 33–44°
240-series and 1980 and later 4 cyl.: 45–63°
260-series and 1980 and later 6 cyl.: 33–63°

② 164: 540–660 ohms
240-series and 1980 and later 4 cyl.: 950–1250 ohms
260-series and 1980 and later 6 cyl.: 540–660 ohms

Fig. 20 Troubleshooting flowchart for a common breakerless ignition system

REPLACING THE IMPULSE SENDER

See Figures 21, 22 and 23

1. Unsnap the lock clasps.
2. Remove the cap, rotor and dust cover.
3. Remove the vacuum advance unit and the cap hold-down clips.
4. Remove the screw securing the contact and pull the contact straight out.
5. Remove the impulse sender plate screws.
6. Remove the snap ring and shims and pull the rotor straight off along with the small lock pin.
7. Remove the snap ring holding the sender and lift off the sender and plate.
8. Install the new sender, making sure that the snap ring is properly seated.
9. Continue reassembling in reverse order, noting that the screws for the vacuum unit and the hold-down clips are different lengths. When attaching the new sender to the plate, the connector pins should be directly opposite and above the attachment ear on the plate. When installation is complete, rotate the shaft several times to make sure there is no noise or binding.

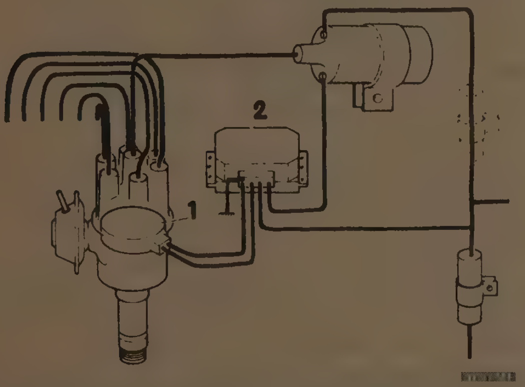


Fig. 21 Common electronic ignition system. "1" is the impulse sender, "2" is the electronic module

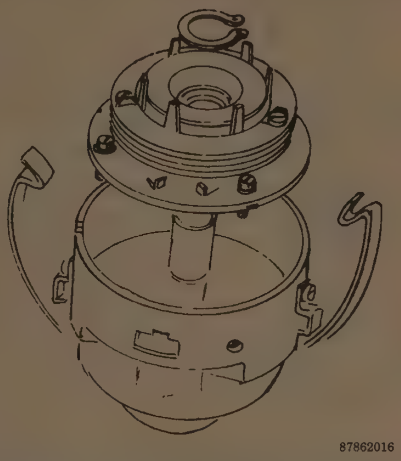


Fig. 22 Exploded view of the impulse sender mounting

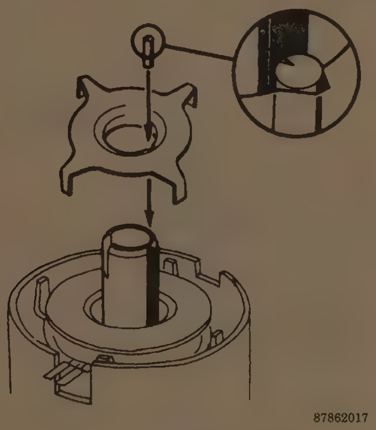


Fig. 23 When installing the trigger wheel, make sure the spilt pin fits in the notch on the distributor shaft

IGNITION TIMING

Inspection and Adjustment

GASOLINE ENGINES

See Figures 24, 25 and 26

Volvo recommends that the ignition timing be checked every 6000 miles (9662 km) on 1970-74 vehicles, 15,000 miles (24,000 km) on 1975-1983 vehicles, and 30,000 miles (48,000 km) on 1984-89 vehicles. Also, a timing adjustment should always follow a breaker point gap and/or dwell angle adjustment (1970-74 models only), and be made with the engine at operating temperature.

Clean the crankshaft damper and pointer on the water pump housing with a solvent-soaked rag so that the marks can be seen. Connect a timing light according to the manufacturer's instructions. Reinforce the marks on the crankshaft damper and on the pointer with chalk or fluorescent paint to highlight the correct timing position. Disconnect and plug the distributor vacuum line (all models) and also disconnect the hose between the air cleaner and the inlet duct at the duct (electronic fuel injected only). Disconnect and plug the vacuum hose at the EGR valve (1973-74 models only). Disconnect and plug the hose from the AIR pump on 1976-77 models so equipped.

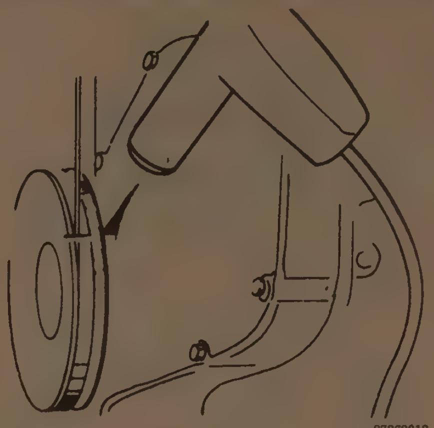


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Fig. 24 Aim the timing light at the marks on the damper

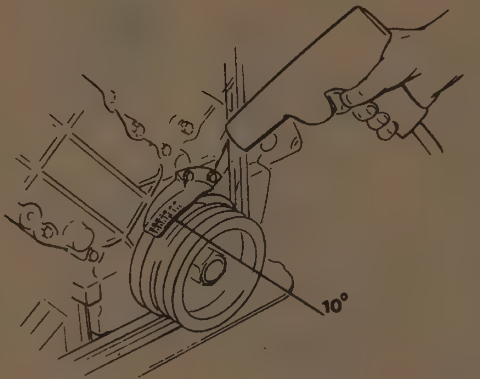

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Fig. 25 Timing marks for B27F and B28F engines

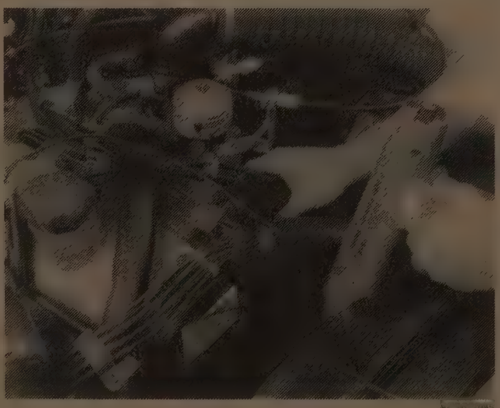

Fig. 26 With the timing light connected, turn the distributor cap as necessary to adjust the ignition timing

Attach a tachometer to the engine and set the idle speed to specifications. With the engine running, aim the timing light at the pointer and the marks on the damper. If the marks do not coincide, stop the engine, loosen the distributor pinch bolt, and start the engine again. While observing the timing light flashes on the markers, grasp the distributor vacuum regulator and rotate the distributor until the marks do coincide. Stop the engine and tighten the distributor pinch bolt, taking care not to disturb the setting.

****CAUTION**

Do not grasp the distributor cap or wires! You may receive a nasty, high-voltage shock.

Reconnect all disconnected hoses and remove the timing light and tachometer leads from the engine.

DIESEL ENGINES

◗ See Figures 27, 28 and 29

****WARNING**

The use of the correct special tools or their equivalent is REQUIRED for this procedure.

1. Remove the rear timing gear cover and disconnect the cold-start device. Loosen the forward screw on the cold-start device control lever, press the lever back toward the stop.

➡Do not loosen the screw closest to the timing belt.

2. Rotate the engine to align the mark on the injection gear with the mark on the pump bracket. The "0" mark on the flywheel should be centered at the timing mark window and with No. 1 cylinder at top dead center.
3. Remove the plug from the rear of the pump and install the Volvo dial indicator adapter No. 5194 or equivalent, with a measuring range of 0-0.1 in. (0-3mm). Set the indicator gauge at approximately 0.08 in. (2mm).

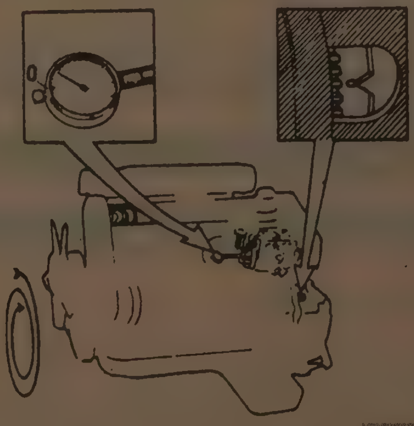

Fig. 27 Use a dial indicator to check injection pump timing by referencing the notch — D24 and 24T models

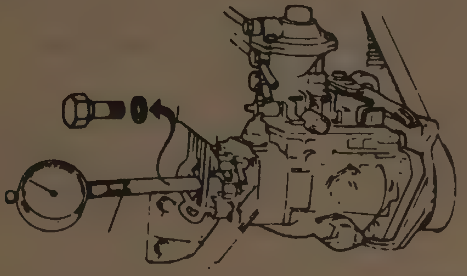

Fig. 28 Install the dial indicator as shown

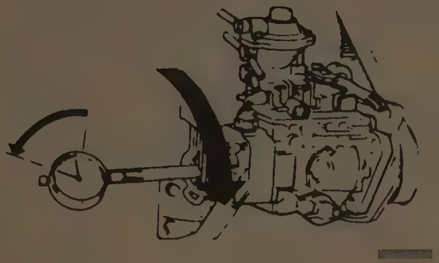

Fig. 29 With the dial indicator properly installed, set the diesel injection pump timing as shown

4. Rotate the engine slowly counterclockwise until the lowest reading on the dial indicator is observed, then re-set the dial indicator to zero.
5. Rotate the engine slowly in the clockwise direction until the "0" mark on the flywheel is centered at the timing mark window. The dial indicator should read within the specified range.

➡When the engine is turned past the timing mark, turn the engine back a ¼ of a turn. Rotate the engine in the clockwise direction until the "0" mark on the flywheel is centered in the timing mark window.

6. If the dial indicator setting is outside the specified range, loosen the pump bolts and turn the pump until the dial indicator shows the correct setting. Then re-tighten the pump bolts.
7. Crank the engine over by hand two revolutions and recheck the injection pump timing. If it is still out of specifications readjust as necessary.
8. Remove the dial indicator and adapter, reinstall the rear plug and rear timing gear cover, then reconnect the cold start device.

VALVE LASH

Adjustment

The recommended maintenance interval for valve clearance adjustment is 12 months/12,000 miles (19,324 km) on 1970-74 models and 12 months/15,000 miles (24,155 km) on 1975-76 models. 1984-86 gasoline engines require valve adjustment at 30,000 miles (48,309 km); diesels require adjustment at 15,000 miles (24,155 km). 1987-89 gasoline engines require inspection and adjustment at 60,000 miles (96,618 km). The clearance may be checked with the engine hot or cold.

Remove the valve cover and crank the engine until number one cylinder is at Top Dead Center (TDC). TDC is the point at which both intake and exhaust valves are fully closed and the piston is on its compression stroke. To find TDC, crank the engine, preferably with a remote starter switch, until the pushrods for both valves on the subject cylinder stop rising (both valves closed). Stop cranking the engine. At this point, it will be easier to find TDC by turning the engine over manually. To accomplish this, remove all of the spark plugs so the compression and resistance to cranking are diminished, and remove the distributor cap so the position of the rotor may be observed. To crank the engine manually, position a socket or closed-end wrench — with a long handle for greater leverage — on the crankshaft damper bolt and turn the crankshaft in the required direction.

✲✲WARNING

Do not attempt to crank the engine by grasping the viscous-drive fan as damage to the fan may result.

At TDC, the piston for the subject cylinder should be at its highest point of travel. Make a visual check or insert a screwdriver through the spark plug hole to make sure that the piston is no longer traveling upward. As an additional check, the distributor rotor should be pointed to the spark plug wire for the subject cylinder at TDC.

Number one cylinder is at TDC when the 0 degree mark on the crankshaft damper aligns with the pointer on the water pump housing. On four-cylinder models, with number one cylinder at TDC, valves (counting from the front) 1, 2, 3, and 5 may be adjusted. On six-cylinder models, with number one cylinder at TDC, valves 1, 2, 3, 6, 7, and 10 may be adjusted.

GASOLINE ENGINES

B20 and B30 Engines

Insert a feeler gauge of the specified thickness between the rocker arm and the valve stem. Adjustment is accomplished by loosening the locknut and turning the adjusting screw and then, without disturbing the adjustment, retightening the locknut.

The remainder of the valves may be adjusted in the following manner. On four-cylinder models, with No. 4 cylinder at TDC, valves (counting form the front) 4, 6, 7, and 8 may be adjusted. On six-cylinder models, with No. 6 cylinder at TDC, valves 4, 5, 8, 9, 11, and 12 may be adjusted.

B21, B23, B230 and B234 Engines

➧ See Figures 30, 31, 32, 33, 34 and 35

➡The B234 16-valve engine has self adjusting valves and hydraulic tappets. They cannot be adjusted during routine maintenance.

Valve clearance is checked every 15,000 miles (24,155 km). If it is necessary to adjust valve clearance, you will need three special tools: first, a valve tappet depressor tool used to push down the tappet sufficiently to remove the adjusting disc (Volvo tool No. 999 5022); second, specially shaped pliers to actually remove and install the valve adjusting disc (Volvo tool No. 999 5026); and third, a set of varying-thickness valve adjusting discs (sometimes called shims) to make the necessary corrections.

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure.

The procedure for checking, and, if necessary, adjusting the valves is as follows:

1. Remove the valve cover. Scribe and number chalk marks on the distributor body indicating each of the four spark plug wire leads in the cap. Remove the distributor cap.
2. Crank over the engine with a remote starter switch or with a wrench on the crankshaft pulley center bolt (22mm hex) until the engine is in the firing position for No. 1 cylinder. At this point, the 0° or TDC mark on the crankshaft pulley is aligned with the timing pointer, the rotor is pointing at the No. 1 spark plug wire cap position, and the cam shaft lobes for No. 1 cylinder are pointing at the 10 o'clock and 2 o'clock positions. At this point, the clearance between the rocker arm and valve depressor (tappet) may be checked for the intake and exhaust valves of cylinder No. 1, using a feeler gauge. When checking clearance, the wear limit is 0.010-0.018 in. (0.25-0.45mm) for a cold engine, and 0.012-0.020 in. (0.30-0.50mm) for a hot engine above 176°F (80°C).
3. Repeat Step 2 for cylinders 3, 4, and 2 (in that order). Each time, rotate the crankshaft pulley 180° so that the rotor is pointing to the spark plug wire cap position for the cylinder, and the cam lobes are pointing at the 10 and 12 o'clock positions for the valves of that cylinder.
4. If any of the valve clearance measurements are outside the wear limit, you will have to remove the old valve adjusting disc and install a new one to bring the clearance within specifications. First, rotate the valve depressors (tappets) until their notches are at a right angle to the engine center line. Attach valve depressor tool 999 5022 to the camshaft and screw down the tool spindle until the depressor (tappet) groove is just above the edge of its bore and still accessible with the special pliers (tool No. 999 5026).
5. Remove the valve adjusting disc and measure with a micrometer. Once you've done this much work, the valve clearance should be set to these tolerances: 0.014-0.016 in. (0.35-0.40mm) for a cold engine, and 0.016-0.018 in.

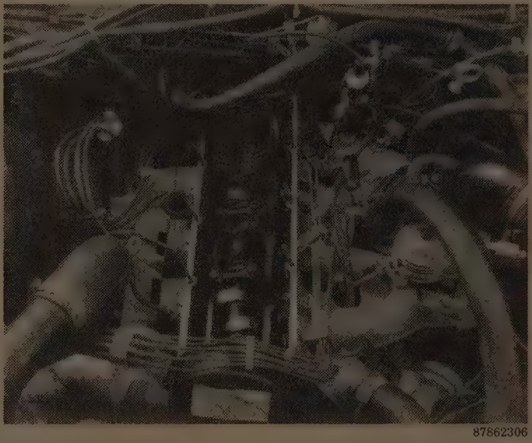

Fig. 30 Remove the valve cover, then manually turn the engine to the correct position

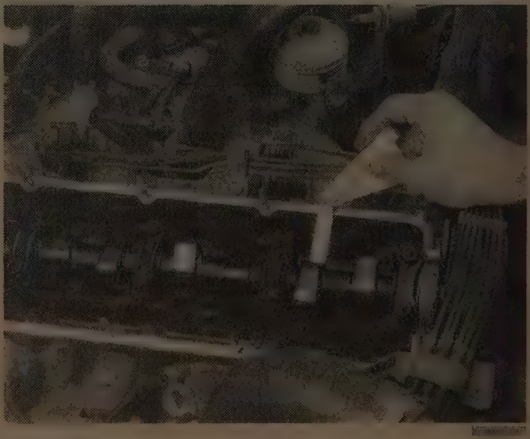

Fig. 31 Use a feeler gauge to determine the proper clearance

(0.40-0.45mm) for a hot one. So, if the measured clearance had been 0.019 in. (0.48mm) and the desired clearance 0.016 in. (0.40mm), for a net difference of 0.003 in. (0.08mm), then the new valve adjusting disc should be 0.003 in. (0.08mm) thicker than the old one to take up the clearance. Valve adjusting discs are available from Volvo in sizes from 0.35mm to 0.45mm (in 0.05mm increments). Always oil the new disc and install it with the marks facing down.

6. Remove the valve tappet depressor tool. Rotate the engine a few times and recheck clearance. Install the valve cover with a new gasket. Volvo does not recommend the use of any sealer on its gaskets.

B27, B28 and B280 Engines

➧ See Figures 36, 37 and 38

Check the valve clearance every 15,000 miles (24,155 km).

1. In order to gain access to the valve covers, disconnect or remove the following:
   a. Air conditioning compressor from bracket (do not disconnect refrigerant hoses)

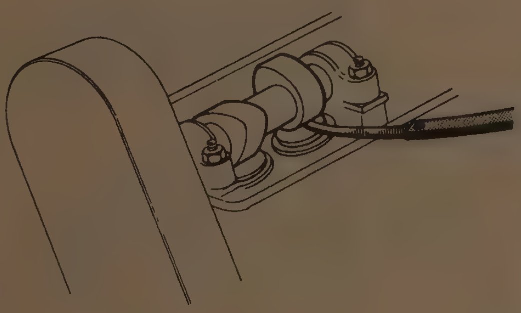

Fig. 32 Use a feeler gauge to measure the valve clearance — B21 and B23 engines

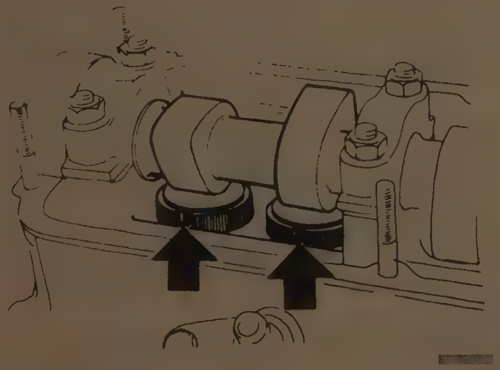

Fig. 33 Rotate the tappets until their notches are at right angles to the engine center line — B21 and B23 engines

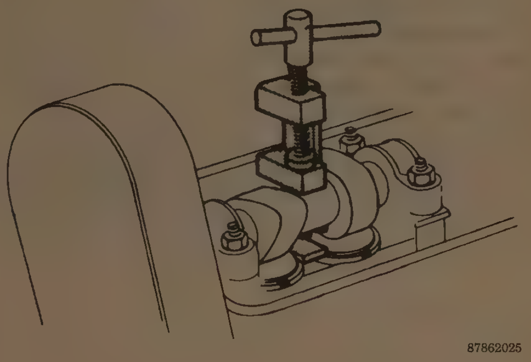

Fig. 34 To adjust valve clearance, attach a valve depressor to the camshaft as shown and screw down

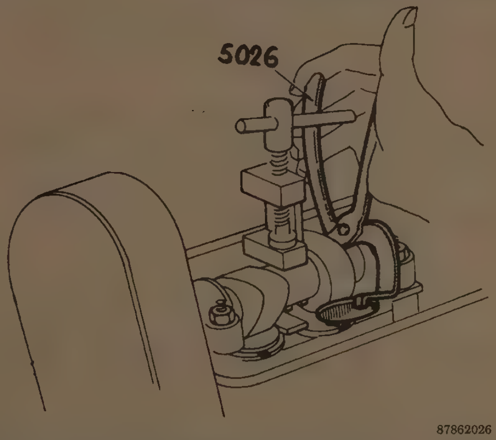

Fig. 35 Remove the adjusting disc using the special pliers as shown

   b. EGR valve and hoses
   c. Air conditioning compressor bracket
   d. Fuel injection control pressure regulator
   e. Air pump
   f. Vacuum pump
   g. Hoses and wires from solenoid valve (California only)

2. Using a 36mm hex socket on the crankshaft pulley bolt, rotate the crankshaft to the No. 1 cylinder TDC position. At this point the "O" mark on the timing plate aligns with the crankshaft pulley notch, the distributor rotor is pointing to the No. 1 cylinder spark plug wire cap position, and both valves for No. 1 cylinder have clearance. Be careful, since these engines have two notches: one for No. 1 cylinder TDC and one for No. 6 cylinder TDC. At this position, adjust the intake valves of cylinders No. 1, 2, and 4, and the exhaust valves of cylinders No. 1, 3 and 6. Insert a feeler gauge between the rocker arm and valve stem. Loosen the locknut and turn the adjusting screw in the required direction. Tighten the locknut and recheck the clearance.

3. Rotate the crankshaft pulley one full 360° turn to adjust the remaining valves. At this point, the "O" mark will again align with the pulley notch, the rotor is pointing 180° opposite to its former position, and the No. 1 cylinder rockers contact the ramps of the camshaft. At this position (see illustration), adjust the intake valves of cylinders No. 3, 5 and 6, and the exhaust valves of cylinders No. 2, 4, and 5.

4. Install the valve covers with new gaskets. Connect all disconnected equipment, taking care that all lines and hoses are attached to the correct ports and are not pinched or kinked. Check also that the compressor bolts are secure and that the belt is properly adjusted for tension.

DIESEL ENGINES

D24 and D24T Engines

➧ See Figures 39, 40, 41 and 42

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure.

Always check valve clearances with the cylinder at TDC; rotate the engine ¼ turn past TDC to set the valves.

1. Remove the valve cover.
2. Use a 17mm socket on the crankshaft pulley. Turn the pulley until the engine is ready to fire on the No. 1 cylinder. The flywheel timing mark should be at zero.

➡The piston should be at ¼ turn past Top Dead Center when setting the valve clearance.

3. Line up the valve depressors.
4. Turn them so that the notches point slightly upward.

➡Use tool No. 5196 or equivalent to press the valve depressors. This tool is available from your Volvo dealer.

5. The depressor grooves must be above the face so that the disc can be gripped with pliers. These pliers are available from your Volvo dealer under part No. 5195.

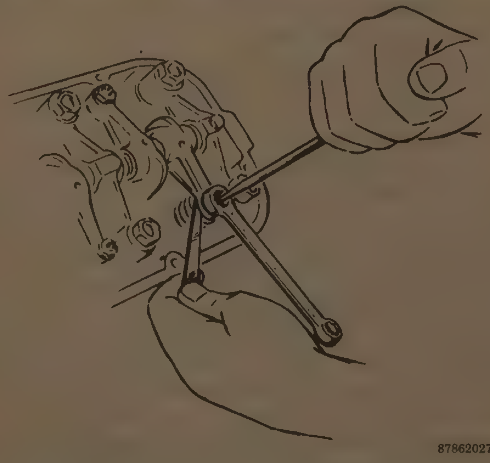
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Fig. 36 Adjust the valves as shown — B27, B28 engines

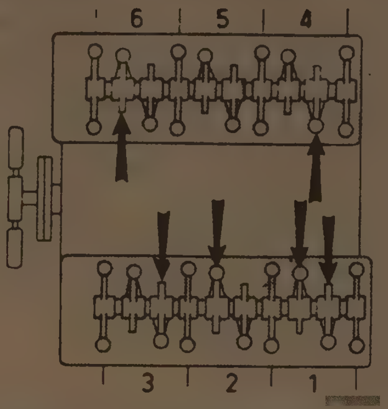

Fig. 37 With the No. 1 cylinder at TDC of the compression stroke, adjust the valves indicated by the arrows — B27 and B28 engines

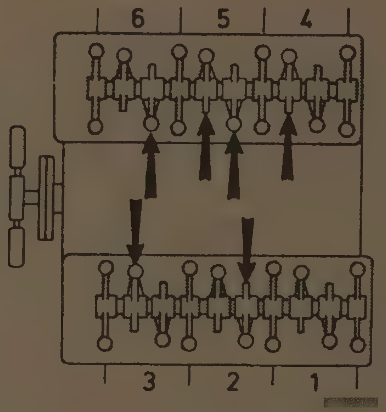

Fig. 38 Turn the engine crankshaft 360° and adjust the remaining valves indicated by the arrows — B27 and B28 engines

6. Remove the disc.
7. Measure the disc thickness, using a micrometer.
8. Observe the following specifications when selecting new discs: Cold engine: 0.02mm (intake), 0.04mm (exhaust). Warm engine: 0.025mm (intake), 0.045mm (exhaust). Discs are available in thicknesses of 0.33-0.43mm, in increments of 0.05mm.

➡Always use new discs when performing this procedure.

9. Oil the new disc and install its marked side down.
10. Check the remaining valve clearances.
11. Use the following sequence: 1-5-3-6-2-4.
12. Recheck the valve clearance for all cylinders.
13. Rotate the engine several times, and recheck the clearance.
14. Install the valve cover with a new gasket.

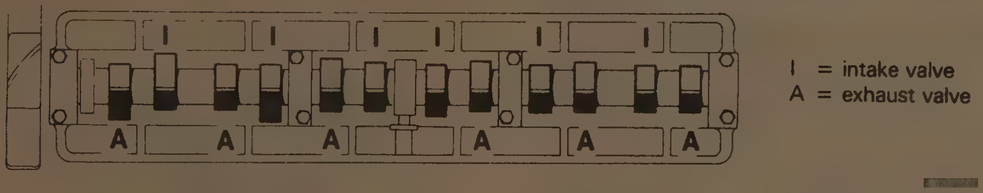
I
I
I
I
I
I
A
A
A
A
A
A
I = intake valve
A = exhaust valve

Fig. 39 Location of intake and exhaust valves for diesel engines

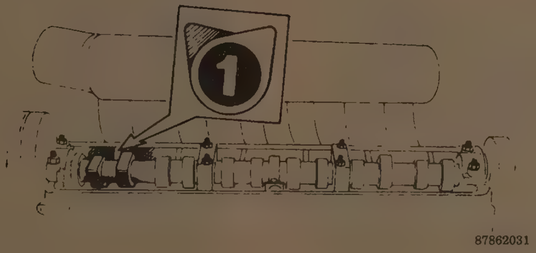

Fig. 40 Make sure the camshaft lobes are positioned as shown with the piston at TDC before checking the valve lash

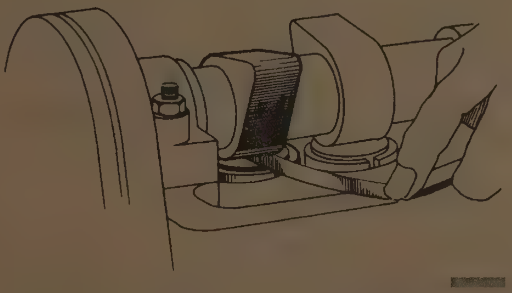

Fig. 41 Use a feeler gauge as shown to check valve clearance

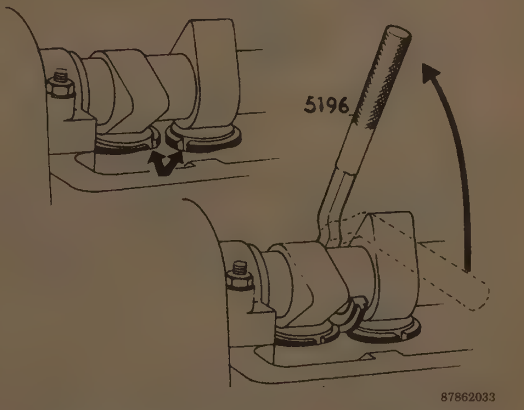
5196
87862033

Fig. 42 When adjusting the valves, rotate the engine ¼ turn past TDC, and align the notches in the valve depressors. Depress the valves using the special tool

IDLE SPEED AND MIXTURE ADJUSTMENTS

Carbureted Engines

IDLE SPEED & MIXTURE ADJUSTMENTS

Zenith-Stromberg 175 CD 2SE Carburetor

➧ See Figures 43 and 44

1. Check the oil level in the damper cylinders. Top off as necessary as outlined in Section 1.
2. Run the engine until it has reached full operating temperature. A good way to check this is to feel the upper radiator hose. When the engine reaches operating temperature (180°F/82°C), the thermostat opens and fills the upper radiator hose with coolant.
3. Adjust the idling speed of the engine to the specifications on the tune-up chart by turning the throttle stopscrews. Turn the screws on both carburetors equally. Check to make sure that both carburetors have the same air valve lift by visually comparing the distance between the carburetor hosing bridge and the air valve.
4. Adjust the idle mixture of the engine with the idle trimming screws until the highest engine speed is attained. The basic setting is two turns counterclockwise from lock. Again, turn the screws on both carburetors equally.
5. Adjust the idling speed of the engine to specifications with the throttle stopscrews.

SU HIF 6 Carburetor

1. Check the oil level in the damper cylinders. Top off as necessary as outlined in Section 1.
2. Remove the air cleaner.
3. Adjust the fuel jets to their basic setting by lifting the air valve and turning the adjustment screw until the upper edge of the fuel jet is level with the bridge. The jet is then lowered two and one-half turns clockwise. This basic jet setting is correct for a carburetor temperature of approximately 70°F (21°C). Turning the adjusting screw a quarter turn in either direction compensates for temperature differences. Turn the adjusting screw less than the two and one-half turns for temperatures above 70°F (21°C), and more than two and one-half turns for lower temperatures.

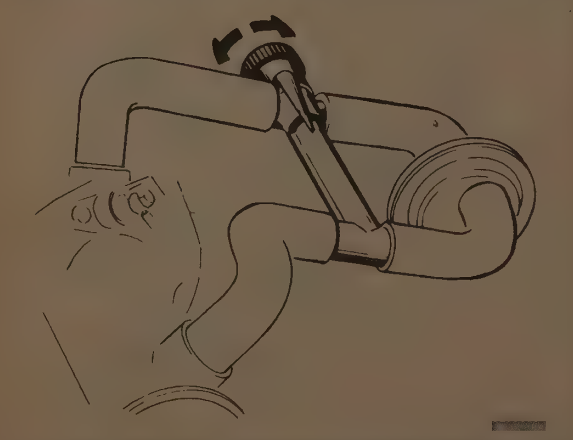

Fig. 43 Adjust the idle speed by turning the screw — 1975 B20F engine with mechanical fuel injection

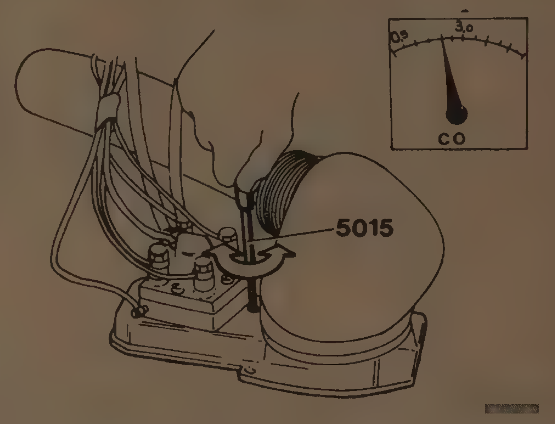

Fig. 44 Adjust the idle mixture as shown — 1975 B20F engine with mechanical fuel injection

4. Run the engine until it has reached full operating temperature. The upper radiator hose should be very warm at this point.
5. Adjust the idling speed of the engine to the specifications on the tune-up chart by turning the throttle stopscrews. Turn the screws on both carburetors equally. Check to make sure that both carburetors have the same air valve lift by visually comparing the distance between the carburetor housing bridge and the air valve.
6. Remove the plastic caps over the mixture adjusting screws. Turn both adjusting screws equally until maximum rpm is achieved. Turn both adjusting screws equally in the opposite direction until the engine just starts to falter. Remember that, in this case, the proper setting is not when maximum rpm is reached but when the engine just starts to falter. As a further check, unscrew the adjusting screws ¼-½ of a turn. The speed should then drop a further 20-40 rpm. Turn back the screws equally to the point where the engine just starts to falter and install the plastic caps over the screws.
7. Adjust the idling speed of the engine to specifications with the throttle stopscrews.

BALANCING DUAL CARBURETORS

Balancing dual carburetors is covered under idle speed and mixture adjustments. To balance the carburetors, make sure both carburetors have the same air valve lift by visually comparing the distance between the carburetor housing bridge and the air valve. A more accurate synchronization is not necessary.

Fuel Injected Engines

IDLE SPEED & MIXTURE ADJUSTMENTS

K-Jetronic (Through 1975) and L-Jetronic Systems

➧ See Figure 45

The idle mixture adjustment or CO value may be set only with the use of a CO meter. This adjustment is made by attaching a CO meter to the exhaust pipe of a vehicle with a warm (176°F/80°C) engine, and turning the adjusting screw of the Bosch control unit (beneath the passenger seat) until the correct CO value is obtained. The correct value is 1-1.5 percent for cars with manual transmissions and 0.5-1.0 percent for cars with automatic transmissions. Because this operation requires highly technical skills and expensive equipment, it is best referred to a Volvo dealer or other competent shop.

The idle speed adjustment may, on the other hand, be set with a tachometer and an average amount of experience. The check should be made with the engine idling at temperature (176°F/80°F). On 140 and 1800 series Volvos, remove the air cleaner-to-inlet duct hose. Check to see that the auxiliary air regulator is closed properly by removing the inlet duct-to-regulator hose and covering the opening with your hand. If the idle speed differs greatly, the engine is not fully warm or the regulator is faulty. Fit the hose again and adjust the idle speed to specifications with the idle adjusting screw. The idle adjusting screw is located on the inlet duct below the air cleaner hose opening on four-cylinder models, and inline in the auxiliary air pipe on six-cylinder models (see illustrations). On 140 and 1800 series Volvos, install the air cleaner hose.

Bosch Continuous Fuel Injection Adjustment (Mechanical)

➡Special Tools Required: CO meter and CO idle mixture adjusting Allen wrench (Volvo tool No. 999 5015). For 1981 and later models, see the Constant Idle Speed (CIS) system.

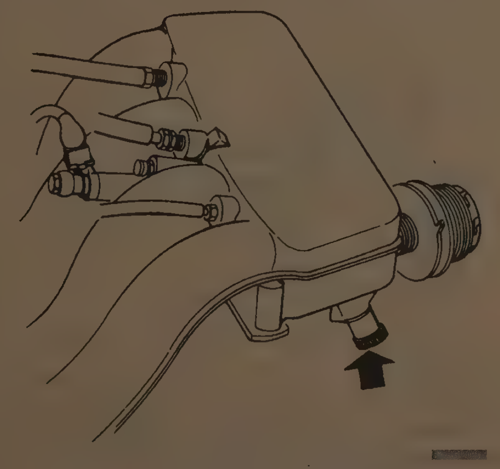

Fig. 45 Mechanical (K-Jetronic) idle speed adjuster

1974-75 B20 F ENGINE

1974 140 series models, and all 240 and 260 series and 1980 models are equipped with the CIS system. With this system, the injectors are open all the time, and the amount of fuel injected is directly proportional to the amount of air drawn into the intake.

The idle mixture adjustment or carbon monoxide (CO) value may be set only with the use of a CO meter. Also, a special tapered setscrew tool is needed to turn the mixture adjusting screw. The adjustment is made with the engine idling at curb idle speed and at operating temperature — 176°F (80°C) with the CO meter attached to the exhaust pipe. 1975 models with air injection require disconnecting and plugging the air pump output hose to prevent an erroneous CO reading. With the special setscrew tool inserted into the small hose between the fuel distributor and the bellows for the air sensor plate, engage the adjusting screw and adjust to a 1.5 percent CO value.

The idle speed adjustment is a simple matter of rotating the idle adjusting screw located in-line in the auxiliary air pipe. With the engine idling at operating temperature — 176°F (80°C) — and the transmission in neutral, adjust to 800 rpm on cars with automatic transmission, and 900 rpm on cars with manual transmission.

B21F ENGINE

➧ See Figure 46

1. Disconnect and plug the air injection pump output hose and the EGR vacuum hose.
2. With the engine warmed to operating temperature — 176°F (80°C) — check that the idle speed is 900 rpm (manual transmission) or 800 rpm (automatic) with the car idling in neutral. Adjust as necessary by rotating the air adjusting screw (knob) located beneath the intake air box.
3. With the engine at specified idle speed, check that the CO value is 2.0 percent (1.0 percent 1977-80). Adjust as necessary by inserting special tool No. 5015 into adjustment hole located between the air intake bellows and the fuel distributor. Recheck the idle speed.

✻✻WARNING

Do not race the engine with the tool inserted.

4. Stop the engine.

B27F AND B28F ENGINES

➧ See Figures 47 and 48

➡Special Tools Required: CO meter with two position switch capable of isolating left or right cylinder banks, CO meter plumbing and fittings to screw into exhaust pipe gas pickup points and CO idle mixture adjusting Allen wrench (Volvo tool No. 999 5102).

1. Remove the air cleaner and housing. Disconnect the air pump output hose (large hose on rear of pump) and plug it with a large diameter screwdriver shaft. Disconnect and plug the vacuum hose at the EGR valve.
2. Set the idle balance screws (No. 1 and No. 2) to their basic setting by screwing them in clockwise until they bottom out, and then backing them off counterclockwise 4 full turns each.

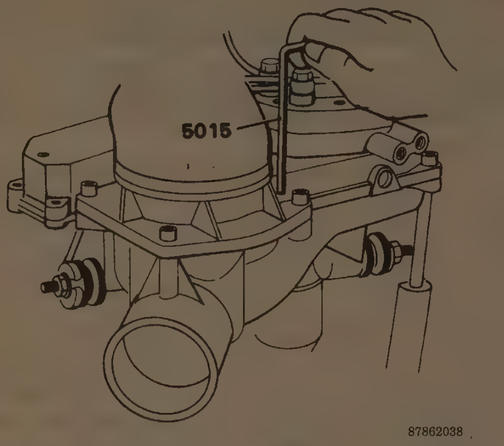

Fig. 46 Adjust the idle mixture as shown — B21F engines

3. Start the engine and allow it to reach operating temperature (176°F/80°C). Using the idle air adjusting screw (No. 3), set the idle speed to 900 rpm.

4. Using the CO meter, check that the carbon monoxide level is 1.4-2.0 percent (1.0 percent 1977-80) at 900 rpm. If necessary, adjust CO level by inserting the special Allen wrench (Volvo tool No. 5102) into the adjustment hose between the fuel distributor and throttle valve, and turning it clockwise to increase CO and counterclockwise to reduce CO. Before inserting the tool, remove the copper washer and plug covering the hose. Also, between adjustments, remove the tool and plug the hose to prevent a lean mixture and erroneous reading. Do not race the engine with tool inserted.

➡On oxygen sensor equipped models, perform CO adjustments with sensor disconnected. When sensor is connected after adjustment, CO should drop below 1 percent.

5. The final step is to check the CO balance between the right and left cylinder banks. Both must have equal CO value; (see Step 4). Air adjusting screw No. 3 controls the total amount of air bypassing the throttle at idle, whereas screws number 1 and 2 divide this air to the two cylinder banks. Screw No. 1 is for the right (passenger) side cylinders, and screw No. 2 is for the left side. If you decrease the airflow past screw No. 2, it will increase the airflow past screw No. 1, and vice versa. More air means a leaner mixture, and less air a richer mixture. After balancing the CO value of each cylinder bank, recheck the total CO value at 900 rpm. Stop the engine.

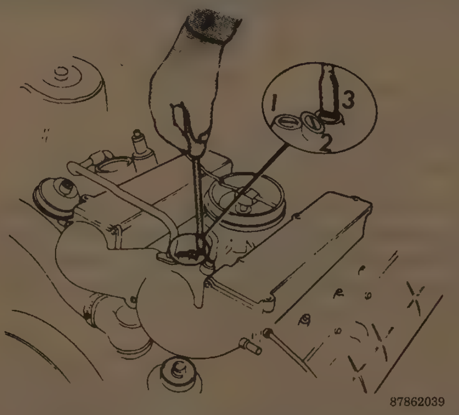

Fig. 47 Location of idle balance screws "1" and "2" and the air adjusting screw "3" — B27F and B28F engines

THROTTLE SWITCH AND BASE IDLE ADJUSTMENTS

Bosch Constant Idle Speed (CIS) System — 1981 and Later

➧ See Figure 49

This system controls the engine idle speed by regulating air flow around (bypassing) the throttle valve in the intake manifold. It is used on engines with both mechanical and LH-Jetronic electronic fuel injection systems.

1981 B21F ENGINE

➧ See Figures 50 and 51

1. Run the engine to normal operating temperature. Disconnect the throttle control rod at the lever. Make sure the cable and pulley run smoothly and do not bind in any position.

2. Remove the Emission Control Unit (ECU) cover panel. De-activate the ECU by disconnecting the white-red wire from terminal 12 of the blue connector plug at the ECU. Reinstall the connector plug.

➡The same wire ends at the ignition coil but cannot be disconnected there.

3. Connect a tachometer to the engine according to the manufacturer's instructions. Connect a test light across the battery positive terminal and the terminal on the throttle micro-switch with the yellow wire connected. Start the engine. The test light must NOT light up. If it does, adjust the micro-switch

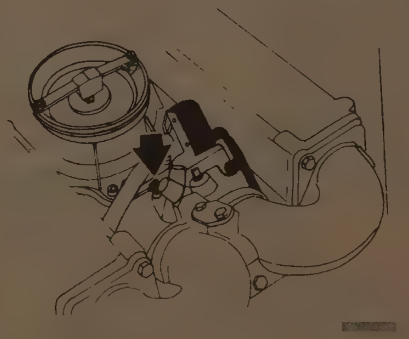

Fig. 48 Make sure the idle speed adjustment screw is bottomed on its seat — 1981-86 B28F engines

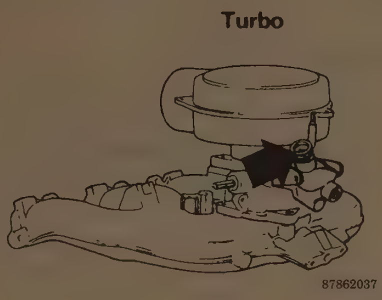

Fig. 49 CIS system idle speed adjuster location

position by slackening the switch retaining screws. Move the switch down until the light goes out, then retighten the screws.

➡This adjustment is temporary; final adjustment will follow later.

4. Idle speed should be 850-900 rpm. If outside these limits, adjust idle speed by proceeding to Step 5. If idle speed is within these limits, continue to Step 6.
5. If the idle speed is outside the stated limits, use the throttle position adjustment screw to adjust the speed to 850-900 rpm. The test light must NOT light up; if it does, readjust the micro-switch position. Reconnect the white-red wire in terminal 12 of the blue connector plug at the ECU to reactivate the ECU. The idle speed should have changed to 900 rpm (850-950 rpm is permitted). Stop the engine.
6. Reconnect the throttle control rod at the lever, making sure the cable pulley is completely retracted. If the control rod length must be adjusted, disconnect the throttle cable and automatic transmission kickdown cable (if equipped). Loosen the locknuts on either end of the rod and adjust the rod as necessary by turning the nut on the end of the cable. Automatic transmission kickdown cable length should be checked at closed and open throttle with the engine **OFF**. Open throttle cable measurement should be checked with the throttle pedal in the car depressed, NOT by actuating the linkage by hand. The cable should be pulled out about 1.97 in. (50mm).
7. Adjust the micro-switch by moving the switch UP, with the engine not running and the throttle closed. Adjust the switch UP until the test light lights up. Set the switch position by moving the switch DOWN 0.08-0.10 in. (2.0-5.5mm). The test light must NOT light or the adjustment will have to be performed again.
8. Remove the test light, reinstall the ECU panel.

1981 B21F-MPG; 1982-83 B21F AND B23E ENGINES

The procedures for these engine models are the same as those for the 1981 B21F above, EXCEPT that the ECU from 1982 on has two extra terminals, 7 and 10, to de-activate the ECU, ground terminal 10 with the connector in place by inserting a copper wire along the terminal wire. Also, the idle speed should be 700 rpm with the ECU de-activated, and 750 rpm (700-800 rpm permitted) with the ECU activated. On Step 2, DO NOT reinstall the connector plug.

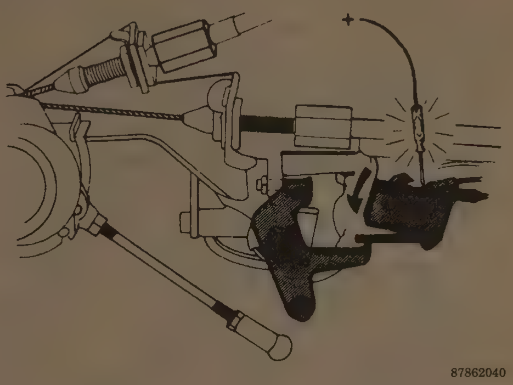

Fig. 50 Adjust the idle speed if the test light illumines at idle speed — B21F engine with CIS

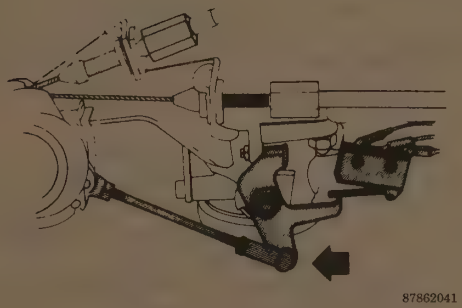

Fig. 51 Disconnect the throttle control rod at this location — B21 engines

1981-85 B21F TURBO ENGINE

➧ See Figures 52 and 53

1. Follow Steps 1 and 2 of the 1981 B21F procedure EXCEPT do not reinstall the connector plug. Note the procedure above for de-activating 1982 and later ECUs.
2. Connect the test light across the battery positive terminal and the orange wire terminal on the throttle micro-switch.The test light must NOT light up while adjusting the idle speed. (The electric circuit through the micro-switch is open.) If the test light illuminates, adjust the micro-switch position by loosening the switch retaining screws and moving the switch down until the test light goes out. Tighten the screws. This is a temporary adjustment; the final adjustment will follow later on.
3. Run the engine to normal operating temperature if not already done. Connect a tachometer to the engine and check idle speed; idle speed should be 850 rpm. If idle speed is outside these limits, follow the procedure below.

4. Using the throttle position adjustment screw, adjust throttle position until the idle speed reaches 850 rpm. The test light must NOT light up. If necessary, adjust the micro-switch position DOWN.

5. Activate the ECU by reconnecting the white-red wire in terminal 12 of the blue connector on 1981 models, and by disconnecting the ground wire that was inserted at terminal 10 of the blue connector on 1982 and later models.

6. After activating the ECU, the idle speed should change to 900 rpm on (850-950 permitted) on 1981 models, and to 900 rpm (880-920 rpm permitted) on 1982 and later models. Stop the engine and install the ECU panel.

7. Reconnect and adjust the throttle control rod and cable, and the automatic transmission kickdown cable (if equipped) by following Step 6 of the 1981 B21F procedure.

8. Adjust the B21F Turbo throttle switch by inserting a 0.12 in (0.3mm) feeler gauge between the throttle adjustment screw and the throttle control lever. Move the switch UP until the test light lights up. Set the switch by moving it DOWN until the test light just goes out. Disconnect all test instruments, install the ECU panel.

IDLE ADJUSTMENT

Bosch LH-Jetronic System

1982 B21F; 1983-89 B23F AND B230F ENGINES

➧ See Figure 54

1. Seat the throttle butterfly valve by loosening the stop nut on the adjuster one or two turns. Set the adjuster screw by screwing it in until it just touches the lever, then screw it in an additional ¼ turn. Tighten the locknut.

2. Disconnect the CIS connector in the firewall. This is the connector that is directly behind the engine.

3. Connect a test light across the battery positive terminal and the orange wire terminal in the connector. Start the engine. The test light SHOULD LIGHT up at idle speed. If it does not, readjust the adjuster screw for the throttle butterfly valve position.

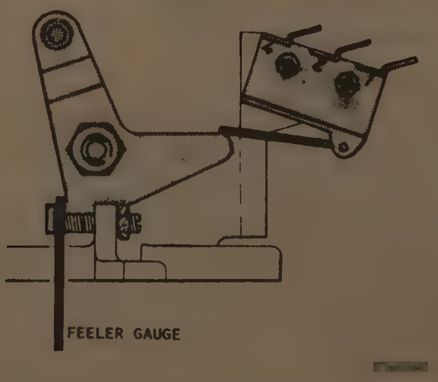

Fig. 52 Use a 0.3mm feeler gauge between the throttle adjustment screw and the throttle control lever — B21F turbo engine

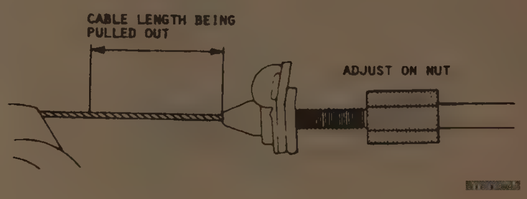

Fig. 53 Turn the adjuster nut to pull or loosen the automatic transmission kickdown cable — B21F turbo

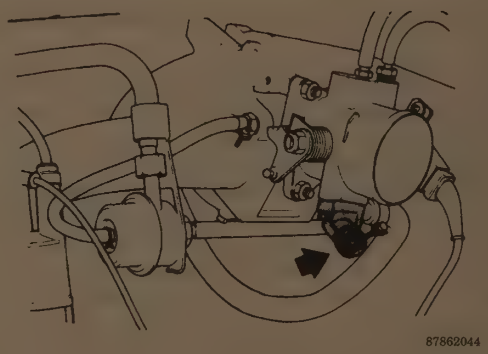

Fig. 54 LH-Jetronic idle adjustment location

4. Open the throttle slightly (by hand) at the throttle control lever, with the engine running. The test light should go out. If it does not, run through the procedure again and try a new throttle switch.

1981-83 B23F ENGINE

1. Disconnect the throttle rod at the cable pulley. Check the cable assembly, making sure the cable and pulley run smoothly and do not bind in any position. Check the throttle; make sure the throttle shaft and plate do not bind during operation.

2. Screw in the idle speed adjustment screw all the way until it just seats.

➡This screw is used to adjust the idle speed on engines without the CIS system.

3. Remove the access panel to the ECU module. (The ECU is located on the passenger's side kick panel on all models except the 760 GLE, on which the ECU is mounted on the driver's side kick panel).

4. On 1981 models, disconnect the white-red wire at terminal 12 of the blue connector plug at the ECU. On 1982 and later models, ground terminal 10 with the connector in place. This can be done by inserting a copper wire along the number 10 terminal wire.

5. Connect a test light across the positive battery terminal and the orange wire terminal on the throttle micro-switch. On 1981 models, the test light should light up while adjusting the micro-switch, indicating current is flowing through the switch. On 1982 and later models, the test light should NOT light up while adjusting the switch, indicating the electric circuit through the micro-switch is interrupted.

6. Connect a tachometer to the engine, and run the engine up to normal operating temperature.

7. Adjust the idle speed by adjusting the throttle position adjustment screw. DO NOT adjust the idle speed screw (it should still be screwed in on its seat).

8. Activate the ECU by reconnecting the white-red wire in the blue connector at the ECU. With the ECU activated, the idle speed should change to 900 rpm on 1981 and 1982 models (850-950 permitted on 1981, 880-920 permitted on 1982) and 750 rpm on 1983. Shut off the engine and install the ECU panel.

9. Reconnect the throttle control rod at the cable pulley. Disconnect the throttle cable and automatic transmission kickdown cable. The cable pulley should be completely retracted. Adjust the control rod length as necessary. Attach and adjust the throttle cable.

10. Check automatic transmission kickdown cable length at closed and open throttle with the engine off. Open throttle measurement should be checked with the throttle pedal in the car depressed, NOT by actuating the linkage by hand. Cable movement should be about 2 in. (50mm). Cable length with closed throttle should be 0.4 in. (1mm); with open throttle, 2.4 in. (51mm).

11. To adjust the throttle micro-switch, insert 0.12 in. (3mm) feeler gauge between the throttle position adjustment screw and the throttle stop. On 1981 models, adjust the switch by turning the adjustment screw until the test light comes on.

1982-86 B28F ENGINE

1. Disconnect the throttle rod at the cable pulley. Check the cable assembly, making sure the cable and pulley run smoothly and do not bind in any position. Check the throttle, make sure the throttle shaft and plate do not bind during operation.

2. Screw in the idle speed adjustment screw all the way until it just seats.

➡This screw is used to adjust the idle speed on engines without the CIS system.

3. Remove the access panel to the ECU module. (The ECU is located on the passenger's side kick panel on all models except the 760 GLE, on which the ECU is mounted on the driver's side kick panel).

4. On 1982-86 models, ground terminal 10 with the connector in place. This can be done by inserting a copper wire along the number 10 terminal wire.

5. Connect a test light across the positive battery terminal and the orange wire terminal on the throttle micro-switch. The test light should NOT light up while adjusting the switch, indicating the electric circuit through the micro-switch is interrupted.

6. Connect a tachometer to the engine, and run the engine up to normal operating temperature.

7. Adjust the idle speed by adjusting the throttle position adjustment screw. DO NOT adjust the idle speed screw (it should still be screwed in on its seat).

8. Activate the ECU. With the ECU activated, the idle speed should change to 900 rpm 1982 models (880-920 rpm permitted) and 750 rpm on 1983-86. Shut off the engine and install the ECU panel.

9. Reconnect the throttle control rod at the cable pulley. Disconnect the throttle cable and automatic transmission kickdown cable. The cable pulley should be completely retracted. Adjust the control rod length as necessary. Attach and adjust the throttle cable.

10. Check automatic transmission kickdown cable length at closed and open throttle with the engine off. Open throttle measurement should be checked with the throttle pedal in the car depressed, NOT by actuating the linkage by hand. Cable movement should be about 2 in. (50mm). Cable length with closed throttle should be about 0.04 in. (1mm); with open throttle, 1.97 in. (50mm).

11. To adjust the throttle micro-switch, insert 0.12 in. (3mm) feeler gauge between the throttle position adjustment screw and the throttle stop. Turn the adjustment screw until the test light lights up.

SWITCH ADJUSTMENT

Full Throttle Enrichment Switch

1982-86 B28F ENGINE

➡The B28F V6 is equipped with two micro-switches actuated by throttle control. This second micro-switch closes a Lambda-Sond (the oxygen sensor) circuit at full throttle to provide richer air/fuel mixture at maximum acceleration. Vehicles sold in high-altitude areas have this switch disconnected.

1. To adjust the switch, loosen the micro-switch retaining screws. Turn the switch sideways. The test light should come on, then go out $^{3}/_{32}$ in. (2.5mm) before the pulley touches the full throttle stop. Tighten the retaining screws.

2. To check full throttle enrichment switch operations, disconnect the green wire at the micro-switch. Connect a test light between the micro-switch terminal and the positive battery terminal.

3. Turn the pulley slowly to the full throttle stop. The test light should light up $^{1}/_{32}$-$^{5}/_{32}$ in. (1-4mm) before the pulley touches the stop. Adjust the switch as necessary, following the switch adjustment procedure above.

1987-89 B280F ENGINE

1. Ground the CIS test point. The CIS test point is the red/white wire in the two wire connector which is located in the engine compartment across from the air conditioning compressor.

2. The green/white wire is the test point location for the oxygen sensor test.

3. Grounding the red/white wire will set the air valve in the wide open position.
4. Adjust the basic idle speed to 700 rpm. Disconnect the ground wire from the CIS test point. The idle speed should increase to 750 rpm.

Diesel Engines

Due to the relative simplicity of the diesel engine compared to the gasoline engine, tune-up procedures consist of adjusting the valves, setting the maximum and minimum engine speeds and adjusting the throttle linkage (every 15,000 miles or 24,155 km), and taking a compression test (every 75,000 miles or 120,773 km).

Valve adjustment procedures are detailed in the Valve Lash Adjustment portion of this section.

IDLE SPEED ADJUSTMENT

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure. To correctly set the idle speed, you will need either the Volvo Monotester and adapter No. 9950 or a suitable photoelectric tachometer. A gasoline engine tachometer by itself cannot be used on a diesel engine, because the diesel does not have an electronic ignition system.

1. Connect a suitable tachometer to the engine and run the engine to normal operating temperature.
2. Idle speed should be 720-880 rpm.
3. If not, adjust the idle speed by loosening the locknut and turning the idle speed screw on the fuel injection pump.
4. Tighten the locknut and apply a dab of paint or thread sealer to the adjusting screw to prevent it from vibrating loose.
5. After adjusting idle speed and maximum engine speed, adjust the engine throttle linkage.

MAXIMUM ENGINE SPEED ADJUSTMENT

The diesel engine is governed by the fuel injection pump so that engine rpms will not exceed 5,100-5,300 rpm. Because of the extremely high compression ratio (23.5:1) and the great stored energy diesel oil contains, the diesel engine cannot be run at the high rpm levels of modern gasoline engines, as it would place a tremendous strain on the pistons, wrist pins, connecting rods and bearings of the engine.

➡To correctly set the idle speed you will need either the Volvo Monotester and adapter No. 9950 or a suitable photoelectric tachometer. A gasoline engine tachometer by itself cannot be used on a diesel engine because the diesel does not have an electronic ignition system.

1. Connect the tachometer and run the engine to normal operating temperature.
2. Run the engine to maximum speed by turning the cable pulley counterclockwise.

✲✲WARNING

Do not race the engine longer than absolutely necessary.

3. Maximum speed should be between 5100-5300 rpm.
4. If not, loosen the locknut and adjust using the maximum speed screw.
5. Tighten the locknut and apply a dab of paint or thread sealer to the adjusting screw to prevent it from vibrating loose.

✲✲WARNING

Do not attempt to squeeze more power out of your diesel by extending the maximum speed.

6. After adjusting the maximum speed, adjust the engine throttle linkage.

THROTTLE LINKAGE ADJUSTMENT

➧ See Figures 55, 56, 57, 58 and 59

If the engine is cold, the cold start device must be disengaged before the linkage can be adjusted. To disengage the cold start device, loosen screw (1) in the illustration, push the lever forward and turn the sleeve 90°

✲✲WARNING

Do not touch screw (2) in the illustration, or the cold start device will have to be reset on the test bench.

To adjust the linkage:

1. Disconnect the link rod lever on the injection pump by unsnapping the plastic clamp on the ball joint of the link rod and pulling the lever off the socket on the accelerator arm.
2. Turn the plastic cable adjuster until the cable is stretched out but does not cause the pulley to move from its idle stop.
3. Have an assistant press the accelerator pedal to the floor and check to see that the pulley notch touches the maximum speed stop.
4. For manual transmission models, proceed to Step 8.
5. To adjust the kickdown cable on models with automatic transmissions, have an assistant press the accelerator pedal to the floor and measure how much inner cable is exposed on the kickdown cable. It should be exposed approximately 2.05 in. (52mm) between the end positions.
6. Return the accelerator pedal to idle position. The kickdown cable should be stretched and the distance between the kickdown cable clip and the cable sheath should be 0.01-0.04 in. (0.25-1.00mm).
7. If either of these measurements are not correct, adjust them at the threaded end of the cable sheath.
8. On all models, connect the link rod to the injection pump accelerator arm.
9. Have an assistant press the accelerator pedal to the floor and adjust the link rod length so that the injection pump accelerator arm touches the maximum speed adjusting screw.

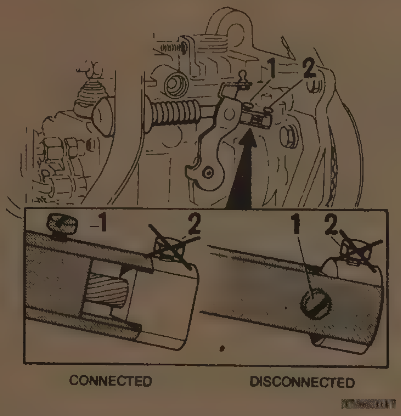

Fig. 55 Disconnect the cold start device as shown — do not loosen screw No. 2, or the cold start device will have to be reset on the test bench

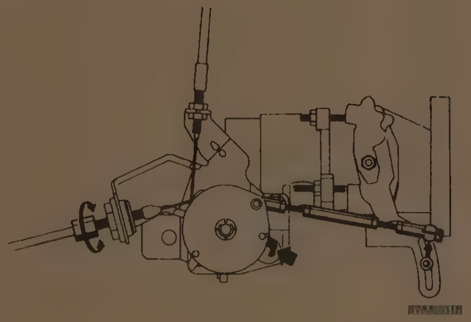

Fig. 56 Disconnect the link rod lever and adjust the cable at its plastic adjuster

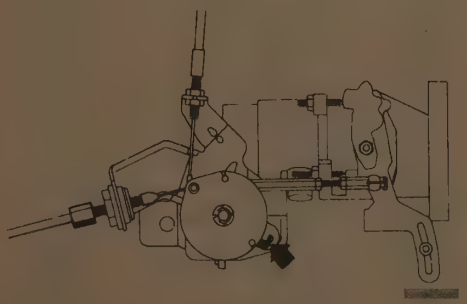

Fig. 57 Depress the accelerator, making sure the pulley notch touches the maximum speed stop

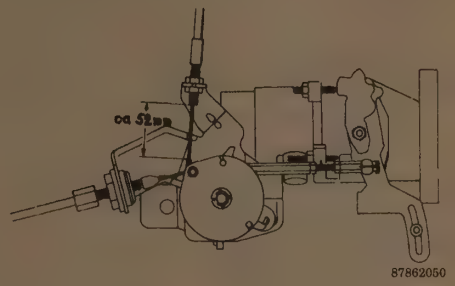

Fig. 58 Adjust the kickdown cable — automatic transmission models

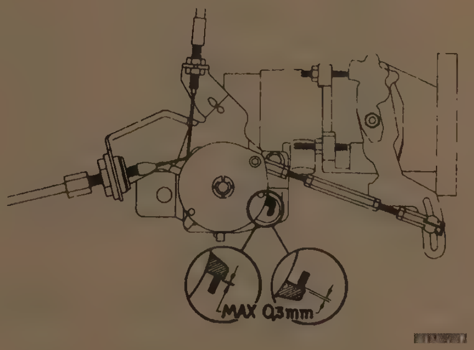

Fig. 59 Maximum clearance between the pulley and maximum speed stop is 0.012 in. (0.3mm)

10. Return the accelerator pedal to the idle position and check to see that the accelerator arm touches the idle speed adjusting screw. If not, loosen and move the link rod ball joint in its oblong slot on the accelerator arm until the arm touches the idle speed adjusting screw. Tighten the ball joint.
11. Repeat Steps 9 and 10 until the linkage is correctly adjusted.

➡A maximum clearance of 0.012 in. (0.3mm) is permitted between the pulley and the maximum speed stop.

12. Connect the cold start device, if it was disengaged.

Gasoline Engine Tune-Up Specifications

When analyzing compression test results, look for uniformity among cylinders, rather than specific pressures.

		Spark Plugs		Distributor		Ignition Timing (deg)		Intake Valve Opens	Fuel Pump Pressure	Idle Speed (rpm)		Valve Clearance (in.)	
Year	Engine Type	Type	Gap (in.)	Point Dwell (deg)	Point Gap (in.)	MT	AT	(deg)	(psi)	MT	AT	In	Ex
1970–72	B 20 B	Bosch W200T35 ③	0.030	59–65	②	10B	10B	TDC	1.56–3.55	800	700	0.020–0.022	0.020–0.022
1970–71	B 20 E	Bosch W225T35 ④	0.030	59–65	0.016–0.020	10B	10B	5.5B	28	900	800	0.016–0.018	0.016–0.018
1972–73	B 20 F	⑤	0.030	59–65	0.014 min.	10B	10B	5.5B	28	900	800	0.016–0.018	0.016–0.018
1970–72	B 30 A	Bosch W200T35	0.030	37–43	0.010 min.	10B	10B	TDC	2.1–3.5	800	700	0.020–0.022	0.020–0.022
1972–73	B 30 F	Bosch W200T35	0.030	37–43	0.010 min.	10B	10B	TDC	28	900	800	0.020–0.022	0.020–0.022
1974	B 20 F	Bosch W200T35	0.030	59–65	0.014 min.	10B ①	10B ①	5.5B	71	900	800	0.016–0.018	0.016–0.018
	B 30 F	Bosch W200T35	0.030	37–43	0.010 min.	10B ①	10B ①	TDC	28	900	800	0.020–0.022	0.020–0.022
1975	B 20 F	Bosch W200T35	0.030	Electronic		10B ①	10B ①	5.5B	71	900	800	0.016–0.018	0.016–0.018
	B 30 F	Bosch W200T35	0.030	Electronic		10B ①	10B ①	TDC	28	900	800	0.020–0.022	0.020–0.022
1976	B 21 F	Bosch W175T30	0.030	Electronic		15B ①	15B ①	15B	64–75	900	800	0.014–0.016	0.014–0.016
	B 27 F	Bosch WA200T30 Champ BN9Y	0.026	Electronic		10B ①	10B ①	⑥	64–75	900	900	0.004–0.006	0.010–0.012
1977	B 21 F	Bosch WA175T30	0.030	Electronic		12B ⑥	12B ⑧	—	64–75	900	900	0.014–0.016	0.014–0.016
	B 27 F	Bosch WA200T30	0.026	Electronic		10B ⑥	10B ⑧	—	64–75	900	900	0.004–0.006	0.010–0.012
1978	B 21 F	Bosch WA175T30	0.030	Electronic		12B ⑧	12B ⑧	—	64–75	900	900	0.014–0.016	0.014–0.016
	B 27 F	Bosch WA200T30	0.030	Electronic		10B ⑥	10B ⑧	—	64–75	900	900	0.004–0.006	0.010–0.012
1979	B 21 F	Bosch W6DC	0.030	Electronic		10B ⑦⑧	10B ⑦⑧	—	64–75	900	900	0.014–0.016	0.014–0.016
	B 27 F	Bosch WA200T30	0.030	Electronic		10B ⑧	10B ⑧	—	64–75	900	900	0.004–0.006	0.010–0.012
1980–'83	B 21 F ⑨	Bosch WR7DS	0.030	Electronic		8B ⑧⑩⑪	8B ⑧⑩⑪	—	64–75	950	950	0.014–0.016	0.014–0.016
	B 21 FT (turbo)	Bosch WR7DS	0.030	Electronic		12B ⑪⑫	12B ⑪⑫	—	64–75	900	900	0.014–0.016	0.014–0.016
	B 21 A	Bosch W7DC	0.030	62	0.016–0.018	12B ⑪⑬⑭	12B ⑪⑬⑭	—	64–75	900	900	0.014–0.016	0.014–0.016
	B 23 E	Bosch W6DC	0.030	Electronic		10B ⑪⑬	10B ⑪⑬	—	64–75	900	900	0.014–0.016	0.014–0.016
	B 23 F ⑮	Bosch WR7DS	0.030	Electronic		12B ⑪⑬	12B ⑪⑬	—	64–75	750	750	0.014–0.016	0.014–0.016
	B 28 F	Bosch WR7DS	0.030	Electronic		10B ⑧⑪⑯	10B ⑧⑪⑯	—	64–75	950	950	0.008–0.010	0.012–0.014

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Gasoline Engine Tune-Up Specifications (cont.)

Year	Model	Engine Displacement cu. in. (cc)	Spark Plugs		Ignition Timing ⑳ (deg.)		Compression Pressure (psi)	Fuel Pump (psi)	Idle Speed (rpm)		Valve Clearance	
			Type	Gap (in.)	MT	AT			MT	AT	In.	Ex.
1984	240 DL	140 (2320) B23F	WR7DS	0.030	12B ⑬	12B ⑬	NA	64–75	750	750	0.014– 0.016	0.014– 0.016
	DL	130 (2127) B21A ⑲	W7DC	0.030	12B ⑬	12B ⑬	NA	64–75	900	900	0.014– 0.016	0.014– 0.016
	GL	140 (2320) B23F	WR7DS	0.030	12B ⑬	12B ⑬	NA	64–75	750	750	0.014– 0.016	0.014– 0.016
	GLE	140 (2320) B23F ⑲	WR7DS	0.030	12B ⑬	12B ⑬	NA	64–75	750	750	0.014– 0.016	0.014– 0.016
	Turbo	130 (2127) B21F-Turbo	WR7DS	0.030	12B ㉑	12B ㉑	NA	64–75	900	900	0.014– 0.016	0.014– 0.016
	760 GLE	174 (2849) B28F	WR6DS	0.026	23B ㉒	23B ㉒	NA	64–75	750	750	0.004– 0.006	0.010– 0.012
	Turbo	140 (2320) B23F-Turbo	WR7DC	0.026	12B ⑬	12B ⑬	NA	64–75	750	750	0.014– 0.016	0.014– 0.016
1985	240 DL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014– 0.016	0.014– 0.016
	GL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014– 0.016	0.014– 0.016
	Turbo	130 (2127) B21F-Turbo	WR7DS	0.030	12B ⑬	12B ⑬	NA	64–75	900	900	0.014– 0.016	0.014– 0.016
	740 GLE	140 (2320) B230F	WR7DS	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014– 0.016	0.014– 0.016
	Turbo	140 (2320) B230F-Turbo	WR7DC	0.026	12B ⑬	12B ⑬	NA	43	750	750	0.014– 0.016	0.014– 0.016
	760 GLE	174 (2849) B28F	HR6DC	0.026	23B ㉒	23B ㉒	NA	64–75	750	750	0.004– 0.006	0.010– 0.012
	Turbo	140 (2320) B230F-Turbo	WR7DC	0.026	12B ⑬	12B ⑬	NA	43	750	750	0.014– 0.016	0.014– 0.016
1986	240 DL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014– 0.016	0.014– 0.016
	GL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014– 0.016	0.014– 0.016
	740 GL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014– 0.016	0.014– 0.016
	GLE	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014– 0.016	0.014– 0.016
	Turbo	140 (2320) B230F-Turbo	WR7DC	0.026	12B ⑬	12B ⑬	NA	43	750	750	0.014– 0.016	0.014– 0.016
	760 GLE	174 (2849) B28F	HR6DC	0.026	23B ㉒	23B ㉒	NA	64–75	750	750	0.004– 0.006	0.010– 0.012
	Turbo	140 (2320) B230F-Turbo	WR7DC	0.026	12B ⑬	12B ⑬	NA	43	750	750	0.014– 0.016	0.014– 0.016
1987	240 DL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014– 0.016	0.014– 0.016
	GL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014– 0.016	0.014– 0.016
	740 GL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014– 0.016	0.014– 0.016

Gasoline Engine Tune-Up Specifications (cont.)

Year	Model	Engine Displacement cu. in. (cc)	Spark Plugs		Ignition Timing ⑳ (deg.)		Compression Pressure (psi)	Fuel Pump (psi)	Idle Speed (rpm)		Valve Clearance	
			Type	Gap (in.)	MT	AT			MT	AT	In.	Ex.
1987	GLE	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014–0.016	0.014–0.016
	Turbo	140 (2320) B230F-Turbo	WR7DC	0.026	12B ⑬	12B ⑬	NA	43	750	750	0.014–0.016	0.014–0.016
	760 GLE	174 (2849) B280F	HR6DC	0.026	16B ⑬	16B ⑬	NA	35	750	750	0.004–0.006	0.010–0.012
	Turbo	140 (2320) B230F-Turbo	WR7DC	0.026	12B ⑬	12B ⑬	NA	43	750	750	0.014–0.016	0.014–0.016
	780 780	174 (2849) B280F	HR6DC	0.026	16B ⑬	16B ⑬	NA	35	750	750	0.004–0.006	0.010–0.012
1988	240 DL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014–0.016	0.014–0.016
	GL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014–0.016	0.014–0.016
	740 GL	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014–0.016	0.014–0.016
	GLE	140 (2320) B230F	WR7DC	0.030	12B ⑬	12B ⑬	NA	36	750	750	0.014–0.016	0.014–0.016
	Turbo	140 (2320) B230F-Turbo	WR7DC	0.026	12B ⑬	12B ⑬	NA	43	750	750	0.014–0.016	0.014–0.016
	760 GLE	174 (2849) B280F	HR6DC	0.026	16B ⑬	16B ⑬	NA	35	750	750	0.004–0.006	0.010–0.012
	Turbo	140 (2320) B230F-Turbo	WR7DC	0.026	12B ⑬	12B ⑬	NA	43	750	750	0.014–0.016	0.014–0.016
	780 780	174 (2849) B280F	HR6DC	0.026	16B ⑬	16B ⑬	NA	35	750	750	0.004–0.006	0.010–0.012
1989	ALL	SEE UNDERHOOD SPECIFICATIONS STICKER										

NOTE: Some models are equipped with the Constant Idle Speed system (CIS) and cannot be adjusted.

B—Before Top Dead Center
① @ 700 rpm
② 1972: 0.014 in.
1970–71: 0.016–0.020 in.
③ Severe service: W225T35
④ Severe service: W240T1
⑤ 1972: Bosch W225T35
1973: Bosch W200T35
⑥ Left side: 9B
Right side: 7B
⑦ Calif: 8B
⑧ 1980–82: @ 700–800 rpm
⑨ Includes Calif. and L-Jetronic models
⑩ 1982 and later: 12°
⑪ Vacuum advance disconnected, A/C turned off
⑫ @ 900 rpm
⑬ @ 750 rpm
⑭ 1982 and later: 7°
⑮ LH-Jetronic injection w/constant idle speed and knock sensor
⑯ 1983: 0.026 in.
⑰ 1983: 0.016 in.
⑱ 1983: @ 800 rpm
⑲ Canada only
⑳ Vacuum advance A/C turned off disconnected,
㉑ @ 900 rpm
㉒ @ 2500 rpm

Diesel Engine Tune-Up Specifications

Year	Model	Engine Displacement cu. in. (cc)	Valve Clearance ① Intake (in.)	Valve Clearance ① Exhaust (in.)	Intake Valve Opens (deg.)	Injection Pump Setting ⑧ (deg.)	Injection Nozzle Pressure (psi) New Used	Idle Speed (rpm)	Cranking Compression Pressure (psi) ⑤
1982	240 GL	145 (2383) D24	0.006– 0.010	0.014– 0.018	NA	0.0265– 0.0295 ②	1845–1700 ③	720– 880 ④	340– 455
1983	240 DL	145 (2383) D24	0.006– 0.010	0.014– 0.018	NA	0.0265– 0.0295 ②	1845–1700 ③	720– 880 ④	340–
	GL	145 (2383) D24	0.006– 0.010	0.014– 0.018	NA	0.0265– 0.0295 ②	1845–1700 ③	720– 880 ④	340– 455
	760 GLE	145 (2383) D24 Turbo ⑥	0.006– 0.010	0.014– 0.018	NA	0.0283– 0.0315	2318–2062 ⑦	750	313– 455
1984	240 Diesel	145 (2383) D24	0.006– 0.010	0.014– 0.018	NA	0.0265– 0.0295 ②	1845–1700 ③	720– 880 ④	340– 455
	760 GLE	145 (2383) D24 Turbo	0.006– 0.010	0.014– 0.010	NA	0.0283– 0.0315	2318–2062 ⑦	750	313– 455
1985	240 Diesel	145 (2383) D24	0.006– 0.010	0.014– 0.018	NA	0.0265– 0.0295 ②	1845–1700 ③	720– 880 ④	340– 455
	740 TD (S)	145 (2383) D24 Turbo ⑥	0.006– 0.010	0.014– 0.018	NA	0.0283– 0.0315	2318–2062 ⑦	830	313– 455
	760 GLE TD	145 (2383) D24 Turbo ⑥	0.006– 0.010	0.014– 0.018	NA	0.0283– 0.0315	2318–2062 ⑦	830	313– 455
1986	740 GLE TD	145 (2383) D24 Turbo ⑥	0.006– 0.010	0.014– 0.018	NA	0.0283– 0.0315	2318–2062 ⑦	830	313– 455

NOTE: When setting injection timing, distributor plunger stroke must be at Top Dead Center

① Cold

② See text. Acceptable range when checking 0.0287–0.0315 in.

③ Acceptable range. When servicing set to 1775–1920 psi

④ Maximum safe speed: 5100–5200 rpm (high idle)

⑤ Maximum difference between cylinders 115 lbs. psi

⑥ Turbo-Diesel

⑦ Acceptable range. When servicing set to 2205–2318 psi.

⑧ Plunger stroke

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Troubleshooting Engine Performance

Problem	Cause	Solution
Hard starting (engine cranks normally)	• Binding linkage, choke valve or choke piston	• Repair as necessary
	• Restricted choke vacuum diaphragm	• Clean passages
	• Improper fuel level	• Adjust float level
	• Dirty, worn or faulty needle valve and seat	• Repair as necessary
	• Float sticking	• Repair as necessary
	• Faulty fuel pump	• Replace fuel pump
	• Incorrect choke cover adjustment	• Adjust choke cover
	• Inadequate choke unloader adjustment	• Adjust choke unloader
	• Faulty ignition coil	• Test and replace as necessary
	• Improper spark plug gap	• Adjust gap
	• Incorrect ignition timing	• Adjust timing
	• Incorrect valve timing	• Check valve timing; repair as necessary
Rough idle or stalling	• Incorrect curb or fast idle speed	• Adjust curb or fast idle speed
	• Incorrect ignition timing	• Adjust timing to specification
	• Improper feedback system operation	• Refer to Chapter 4
	• Improper fast idle cam adjustment	• Adjust fast idle cam
	• Faulty EGR valve operation	• Test EGR system and replace as necessary
	• Faulty PCV valve air flow	• Test PCV valve and replace as necessary
	• Choke binding	• Locate and eliminate binding condition
	• Faulty TAC vacuum motor or valve	• Repair as necessary
	• Air leak into manifold vacuum	• Inspect manifold vacuum connections and repair as necessary
	• Improper fuel level	• Adjust fuel level
	• Faulty distributor rotor or cap	• Replace rotor or cap
	• Improperly seated valves	• Test cylinder compression, repair as necessary
	• Incorrect ignition wiring	• Inspect wiring and correct as necessary
	• Faulty ignition coil	• Test coil and replace as necessary
	• Restricted air vent or idle passages	• Clean passages
	• Restricted air cleaner	• Clean or replace air cleaner filler element
	• Faulty choke vacuum diaphragm	• Repair as necessary
Faulty low-speed operation	• Restricted idle transfer slots	• Clean transfer slots
	• Restricted idle air vents and passages	• Clean air vents and passages
	• Restricted air cleaner	• Clean or replace air cleaner filter element
	• Improper fuel level	• Adjust fuel level
	• Faulty spark plugs	• Clean or replace spark plugs
	• Dirty, corroded, or loose ignition secondary circuit wire connections	• Clean or tighten secondary circuit wire connections
	• Improper feedback system operation	• Refer to Chapter 4
	• Faulty ignition coil high voltage wire	• Replace ignition coil high voltage wire
	• Faulty distributor cap	• Replace cap
Faulty acceleration	• Improper accelerator pump stroke	• Adjust accelerator pump stroke
	• Incorrect ignition timing	• Adjust timing
	• Inoperative pump discharge check ball or needle	• Clean or replace as necessary
	• Worn or damaged pump diaphragm or piston	• Replace diaphragm or piston

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Troubleshooting Engine Performance (cont.)

Problem	Cause	Solution
Faulty acceleration (cont.)	• Leaking carburetor main body cover gasket	• Replace gasket
	• Engine cold and choke set too lean	• Adjust choke cover
	• Improper metering rod adjustment (BBD Model carburetor)	• Adjust metering rod
	• Faulty spark plug(s)	• Clean or replace spark plug(s)
	• Improperly seated valves	• Test cylinder compression, repair as necessary
	• Faulty ignition coil	• Test coil and replace as necessary
	• Improper feedback system operation	• Refer to Chapter 4
Faulty high speed operation	• Incorrect ignition timing	• Adjust timing
	• Faulty distributor centrifugal advance mechanism	• Check centrifugal advance mechanism and repair as necessary
	• Faulty distributor vacuum advance mechanism	• Check vacuum advance mechanism and repair as necessary
	• Low fuel pump volume	• Replace fuel pump
	• Wrong spark plug air gap or wrong plug	• Adjust air gap or install correct plug
	• Faulty choke operation	• Adjust choke cover
	• Partially restricted exhaust manifold, exhaust pipe, catalytic converter, muffler, or tailpipe	• Eliminate restriction
	• Restricted vacuum passages	• Clean passages
	• Improper size or restricted main jet	• Clean or replace as necessary
	• Restricted air cleaner	• Clean or replace filter element as necessary
	• Faulty distributor rotor or cap	• Replace rotor or cap
	• Faulty ignition coil	• Test coil and replace as necessary
	• Improperly seated valve(s)	• Test cylinder compression, repair as necessary
	• Faulty valve spring(s)	• Inspect and test valve spring tension, replace as necessary
	• Incorrect valve timing	• Check valve timing and repair as necessary
	• Intake manifold restricted	• Remove restriction or replace manifold
	• Worn distributor shaft	• Replace shaft
	• Improper feedback system operation	• Refer to Chapter 4
Misfire at all speeds	• Faulty spark plug(s)	• Clean or replace spark plug(s)
	• Faulty spark plug wire(s)	• Replace as necessary
	• Faulty distributor cap or rotor	• Replace cap or rotor
	• Faulty ignition coil	• Test coil and replace as necessary
	• Primary ignition circuit shorted or open intermittently	• Troubleshoot primary circuit and repair as necessary
	• Improperly seated valve(s)	• Test cylinder compression, repair as necessary
	• Faulty hydraulic tappet(s)	• Clean or replace tappet(s)
	• Improper feedback system operation	• Refer to Chapter 4
	• Faulty valve spring(s)	• Inspect and test valve spring tension, repair as necessary
	• Worn camshaft lobes	• Replace camshaft
	• Air leak into manifold	• Check manifold vacuum and repair as necessary
	• Improper carburetor adjustment	• Adjust carburetor
	• Fuel pump volume or pressure low	• Replace fuel pump
	• Blown cylinder head gasket	• Replace gasket
	• Intake or exhaust manifold passage(s) restricted	• Pass chain through passage(s) and repair as necessary
	• Incorrect trigger wheel installed in distributor	• Install correct trigger wheel

Troubleshooting Engine Performance (cont.)

Problem	Cause	Solution
Power not up to normal	• Incorrect ignition timing	• Adjust timing
	• Faulty distributor rotor	• Replace rotor
	• Trigger wheel loose on shaft	• Reposition or replace trigger wheel
	• Incorrect spark plug gap	• Adjust gap
	• Faulty fuel pump	• Replace fuel pump
	• Incorrect valve timing	• Check valve timing and repair as necessary
	• Faulty ignition coil	• Test coil and replace as necessary
	• Faulty ignition wires	• Test wires and replace as necessary
	• Improperly seated valves	• Test cylinder compression and repair as necessary
	• Blown cylinder head gasket	• Replace gasket
	• Leaking piston rings	• Test compression and repair as necessary
	• Worn distributor shaft	• Replace shaft
	• Improper feedback system operation	• Refer to Chapter 4
Intake backfire	• Improper ignition timing	• Adjust timing
	• Faulty accelerator pump discharge	• Repair as necessary
	• Defective EGR CTO valve	• Replace EGR CTO valve
	• Defective TAC vacuum motor or valve	• Repair as necessary
	• Lean air/fuel mixture	• Check float level or manifold vacuum for air leak. Remove sediment from bowl
Exhaust backfire	• Air leak into manifold vacuum	• Check manifold vacuum and repair as necessary
	• Faulty air injection diverter valve	• Test diverter valve and replace as necessary
	• Exhaust leak	• Locate and eliminate leak
Ping or spark knock	• Incorrect ignition timing	• Adjust timing
	• Distributor centrifugal or vacuum advance malfunction	• Inspect advance mechanism and repair as necessary
	• Excessive combustion chamber deposits	• Remove with combustion chamber cleaner
	• Air leak into manifold vacuum	• Check manifold vacuum and repair as necessary
	• Excessively high compression	• Test compression and repair as necessary
	• Fuel octane rating excessively low	• Try alternate fuel source
	• Sharp edges in combustion chamber	• Grind smooth
	• EGR valve not functioning properly	• Test EGR system and replace as necessary
Surging (at cruising to top speeds)	• Low carburetor fuel level	• Adjust fuel level
	• Low fuel pump pressure or volume	• Replace fuel pump
	• Metering rod(s) not adjusted properly (BBD Model Carburetor)	• Adjust metering rod
	• Improper PCV valve air flow	• Test PCV valve and replace as necessary
	• Air leak into manifold vacuum	• Check manifold vacuum and repair as necessary
	• Incorrect spark advance	• Test and replace as necessary
	• Restricted main jet(s)	• Clean main jet(s)
	• Undersize main jet(s)	• Replace main jet(s)
	• Restricted air vents	• Clean air vents
	• Restricted fuel filter	• Replace fuel filter
	• Restricted air cleaner	• Clean or replace air cleaner filter element
	• EGR valve not functioning properly	• Test EGR system and replace as necessary
	• Improper feedback system operation	• Refer to Chapter 4

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3

ENGINE AND ENGINE OVERHAUL

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BASIC ELECTRICITY

Understanding the Engine Electrical System

The engine electrical system can be broken down into three separate and distinct systems:

- The starting system
- The charging system
- The ignition system

BATTERY AND STARTING SYSTEM

The battery is the first link in the chain of mechanisms which work together to provide cranking of the automobile engine. In most modern cars, the battery is a lead/acid electrochemical device consisting of six 2V subsections connected in series so the unit is capable of producing approximately 12V of electrical pressure. Each subsection, or cell, consists of a series of positive and negative plates held a short distance apart in a solution of sulfuric acid and water. The two types of plates are of dissimilar metals. This causes a chemical reaction to be set up, and it is this reaction which produces current flow from the battery when its positive and negative terminals are connected to an electrical appliance such as a lamp or motor. The continued transfer of electrons would eventually convert the sulfuric acid in the electrolyte to water, and make the two plates identical in chemical composition. As electrical energy is removed from the battery, its voltage output tends to drop. Thus, measuring battery voltage and battery electrolyte composition are two ways of checking the ability of the unit to supply power. During the starting of the engine, electrical energy is removed from the battery. However, if the charging circuit is in good condition and the operating conditions are normal, the power removed from the battery will be replaced by the generator (or alternator) which will force electrons back through the battery, reversing the normal flow, and restoring the battery to its original chemical state.

The battery and starting motor are linked by very heavy electrical cables designed to minimize resistance to the flow of current. Generally, the major power supply cable that leaves the battery goes directly to the starter, while other electrical system needs are supplied by a smaller cable. During starter operation, power flows from the battery to the starter and is grounded through the car's frame and the battery's negative ground strap.

The starting motor is a specially designed, direct current electric motor capable of producing a very great amount of power for its size. One thing that allows the motor to produce a great deal of power is its tremendous rotating speed. It drives the engine through a tiny pinion gear (attached to the starter's armature), which drives the very large flywheel ring gear at a greatly reduced speed. Another factor allowing it to produce so much power is that only intermittent operation is required of it. This, little allowance for air circulation is required, and the windings can be built into a very small space.

The starter solenoid is a magnetic device which employs the small current supplied by the starting switch circuit of the ignition switch. This magnetic action moves a plunger which mechanically engages the starter and electrically closes the heavy switch which connects it to the battery. The starting switch circuit consists of the starting switch contained within the ignition switch, a transmission neutral safety switch or clutch pedal switch, and the wiring necessary to connect these in series with the starter solenoid or relay.

A pinion, which is a small gear, is mounted to a one-way drive clutch. This clutch is splined to the starter armature shaft. When the ignition switch is moved to the **START** position, the solenoid plunger slides the pinion toward the flywheel ring gear via a collar and spring. If the teeth on the pinion and flywheel match properly, the pinion will engage the flywheel immediately. If the gear teeth butt one another, the spring will be compressed and will force the gears to mesh as soon as the starter turns far enough to allow them to do so. As the solenoid plunger reaches the end of its travel, it closes the contacts that connect the battery and starter and then the engine is cranked.

As soon as the engine starts, the flywheel ring gear begins turning fast enough to drive the pinion at an extremely high rate of speed. At this point, the one-way clutch begins allowing the pinion to spin faster than the starter shaft so that the starter will not operate at excessive speed. When the ignition switch is released from the starter position, the solenoid is de-energized, and a spring contained within the solenoid assembly pulls the gear out of mesh and interrupts the current flow to the starter.

Some starter employ a separate relay, mounted away from the starter, to switch the motor and solenoid current on and off. The relay thus replaces the solenoid electrical switch, buy does not eliminate the need for a solenoid mounted on the starter used to mechanically engage the starter drive gears. The relay is used to reduce the amount of current the starting switch must carry.

CHARGING SYSTEM

The automobile charging system provides electrical power for operation of the vehicle's ignition and starting systems and all the electrical accessories. The battery services as an electrical surge or storage tank, storing (in chemical form) the energy originally produced by the engine driven generator. The system also provides a means of regulating generator output to protect the battery from being overcharged and to avoid excessive voltage to the accessories.

The storage battery is a chemical device incorporating parallel lead plates in a tank containing a sulfuric acid/water solution. Adjacent plates are slightly dissimilar, and the chemical reaction of the two dissimilar plates produces electrical energy when the battery is connected to a load such as the starter motor. The chemical reaction is reversible, so that when the generator is producing a voltage (electrical pressure) greater than that produced by the battery, electricity is forced into the battery, and the battery is returned to its fully charged state.

Newer automobiles use alternating current generators or alternators, because they are more efficient, can be rotated at higher speeds, and have fewer brush problems. In an alternator, the field rotates while all the current produced passes only through the stator winding. The brushes bear against continuous slip rings rather than a commutator. This causes the current produced to periodically reverse the direction of its flow. Diodes (electrical one-way switches) block the flow of current from traveling in the wrong direction. A series of diodes is wired together to permit the alternating flow of the stator to be converted to a pulsating, but unidirectional flow at the alternator output. The alternator's field is wired in series with the voltage regulator.

The regulator consists of several circuits. Each circuit has a core, or magnetic coil of wire, which operates a switch. Each switch is connected to ground through one or more resistors. The coil of wire responds directly to system voltage. When the voltage reaches the required level, the magnetic field created by the winding of wire closes the switch and inserts a resistance into the generator field circuit, thus reducing the output. The contacts of the switch cycle open and close many times each second to precisely control voltage.

While alternators are self-limiting as far as maximum current is concerned, DC generators employ a current regulating circuit which responds directly to the total amount of current flowing through the generator circuit rather than to the output voltage. The current regulator is similar to the voltage regulator except that all system current must flow through the energizing coil on its way to the various accessories.

All Volvos are equipped with a 12 volt, negative ground electrical system which consists of a battery, alternator and voltage regulator, starter motor, ignition system (gasoline engines) or glow plugs (diesel engine), lighting system, accessories, and signaling and instrumentation components. See Section 6, Chassis Electrical, for repair procedures on non-engine related electrical components.

Troubleshooting the Electronic Ignition System

An electronic ignition troubleshooting chart is included in Section 2, along with a brief explanation of the Volvo electronic ignition system.

Troubleshooting procedures for breaker point ignition systems are found in this section.

IGNITION COIL

➧ See Figure 1

All spark-ignition systems (gasoline engines) use a coil as the first component in the ignition system. The coil is simply a step-up transformer, which takes the 12 to 14 volts of the engine's electrical system and increases it to very high voltage. This change is necessary so that the electrical charge can form a sufficiently hot spark when it jumps to ground through the spark plug electrode gap.

✲✲CAUTION

Electronic ignition systems operate at very high voltages, often in excess of 30,000 volts. Such high voltages are a danger to life and special precautions must be taken on vehicles equipped with electronic ignition. Even the older, breaker point ignition systems can deliver a nasty shock to a careless worker.

Fig. 1 The coil is easy to locate by tracing the center wire from the distributor cap back to the coil

The coil is easily found by tracing the center wire in the distributor cap to its opposite end. The coil is generally retained by a bracket, held to the car by one or two bolts. Depending on its position and ease of access, the coil may not need to be removed for testing.

To properly test a coil, you must have an ohmmeter. Generally, this tool is found as a volt/ohmmeter (VOM) and is very useful in automotive diagnosis. The resistance values for the primary side of the coil and ballast resistor (if so equipped) will be very low; make sure your VOM is set on the 0-10 ohm scale. When testing the secondary side of the coil, resistance will be much higher and the scale is usually set on 0-10,000 ohms.

Testing the Coil and Ballast Resistor

➧ See Figures 2, 3, 4, 5 and 6

Perform this work with the engine **OFF** and the key out of the ignition so that there is NO possibility of the ignition being on. Carefully remove the wire to the distributor from the top of the coil. Label and disconnect the other wires attached to the coil, taking care not to lose any of the very small nuts and washers.

Clean off the coil and look for the numbers stamped near the terminals. Terminal No. 1 is ground (or negative), No. 15 is PRIMARY voltage (12 volts) and the terminal labeled HT is SECONDARY or high tension voltage. The HT terminal is the center tower, from which runs the wire to the distributor. Inspect the tower for any signs of cracking. If cracks are found, replace the coil. Check carefully, most coil cracks are hairline thin and hard to see.

To measure the primary side of the coil, connect the leads of the meter to terminals 1 and 15. To read the secondary side, connect to terminals 1 and HT.

The values given in the accompanying chart are based on a coil temperature of 68°F (20°C).

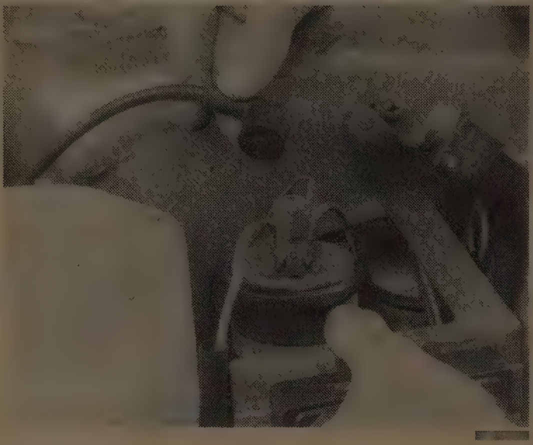

Fig. 2 Inspect the top of the coil for any fine cracks — replace the coil if any are found

Fig. 3 Label and disconnect the wires to ensure a correct installation

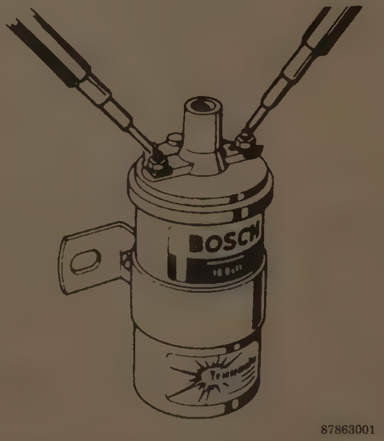

Fig. 4 Check the coil primary windings using terminals 1 and 15

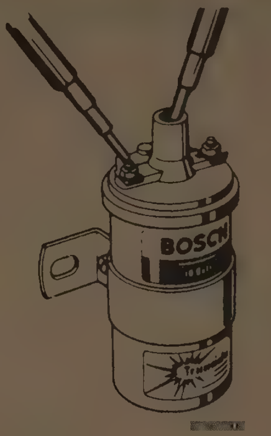

Fig. 5 Check the coil secondary windings using terminal 1 and the HT port

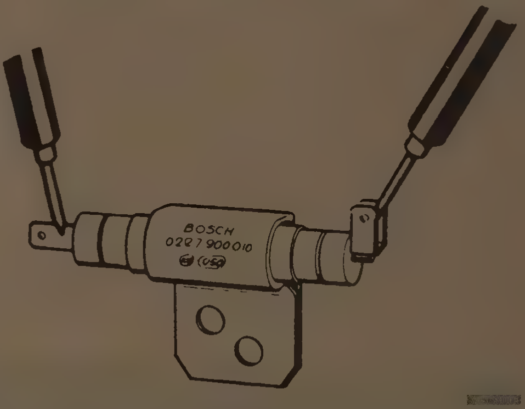

Fig. 6 Use an ohmmeter to check the resistance of the coil ballast

Distributor

➡This procedure pertains to gasoline engines only.

The distributor performs two functions within the ignition system. Its breaker points or impulse sender (electronic ignition) time the collapse of the magnetic field of the ignition coil in relation to engine speed and convert primary voltage (12 volt) to secondary (high) voltage. The rotor and cap then distribute the high voltage spark to the correct spark plug.

The distributor incorporates both centrifugal and vacuum ignition timing mechanisms. Centrifugal advance is controlled by two weights located beneath the breaker plate. As engine speed increases, centrifugal force moves the weights out from the distributor shaft and advances the ignition by changing the position of the cam in relation to the shaft. This advanced positioning of the cam will then open the breaker points sooner and ignite the air/fuel mixture quickly enough in relation to piston speed. Centrifugal advance is necessary because as engine speed increases, the time period available to ignite the

Ignition Specifications

Ignition Type and Engine Family	Coil Resistance				Ballast Resistance
	Primary		Secondary		
Breaker Point Ignition	Ohms		Ohms × 1000 (or KΩ)		Ohms
B20A, B17–B23A through 1978	2.85±0.15		9.5±2.5		—
B20A, B17–B23A 1979 & later	1.9±0.1		9.5±1.5		1.3±0.1
Breakerless ignition B20F–B19, E, ET B21E, ET, F, FT B23E	1.9±0.1		9.5±1.5		0.9±0.1
B27A, E, F B28A, E, F	0.5±0.1		9.5±1.5		1.0±0.1
Computerized IGN Systems	Essex Coil	Bosch Coil	Essex Coil	Bosch Coil	
1981 B21F-MPG 1982 B21 F-CI 1982 B21 F-LH 1983–84 B23F 1985-on B230F	1.2 ± 0.1	1.2 ± 0.1	10.6 ± 1.0	8.5 ± 0.8	—

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mixture decreases. (For example, at idle speed the ignition setting is, perhaps 10° BTDC. This is adequate for the spark plug to ignite the mixture at idle, but not at 2,500 rpm. The weights, governed by springs, move out at a predetermined rate to advance the timing to match engine speed.)

Centrifugal advance is not sufficient to provide the proper advance under all conditions, and so we also have vacuum advance. Under light load conditions, such as very gradual acceleration and low speed cruising, the throttle opening is not sufficient to draw enough air/fuel mixture into the cylinder. Vacuum advance is used to provide the extra spark advance needed to ignite the smaller mixture. The round can on the side of the distributor is the vacuum advance unit. The rubber hose supplies vacuum from the intake manifold to draw on the diaphragm in the unit which is connected by a link to the breaker plate in the distributor. Under part-throttle operation, the vacuum advance moves the breaker plate or impulse sender as necessary to provide the correct advance for efficient operation.

REMOVAL & INSTALLATION

➧ See Figures 7, 8 and 9

1. Unsnap the distributor cap clasps and remove the cap.
2. Crank the engine until No. 1 cylinder is at Top Dead Center (TDC). At this point, the rotor should point to the spark plug wire socket for No. 1 cylinder, and the 0° timing mark on the crankshaft damper should be aligned with the pointer. For ease of assembly, scribe a chalkmark on the distributor housing to note the position of the rotor.
3. Disconnect the primary lead from the coil at its terminal on the distributor housing. On electronic fuel injected models, disconnect the plug for the triggering contacts. On 1975 and later models with electronic ignition, remove the retaining screw for the primary voltage wire connector and pull it from the distributor housing.
4. Label and remove the vacuum hose(s) from the vacuum advance regulator. Take care not to damage the connection during removal.
5. On B20 and B30 engines, loosen the distributor attaching screw and hold-down clamp enough to slide the distributor up and out of position. On B21, B23, B27 and B28 engines, remove the distributor attaching screw and lift out the distributor.
6. Perform the needed tests, repairs or adjustments on the distributor. If the engine has not been disturbed (the crankshaft was not moved since the distributor was taken out), install the distributor with the rotor pointing to the No. 1 cylinder spark plug wire socket, which should be in line with the chalkmark you make prior to removal. If the engine was disturbed, proceed to Step 7.

On the B20 and B30 engines, the distributor has an offset driving collar which can only be inserted one way. On the B21, B23, B27 and B28 engines, the distributor drive has bevelled gear teeth which will cause the rotor to turn counterclockwise as the distributor is installed. For this reason, it is necessary to back off the rotor clockwise (about 60° on the B21, B23, and 40° on the B27, B28) to compensate for this. When the distrib-

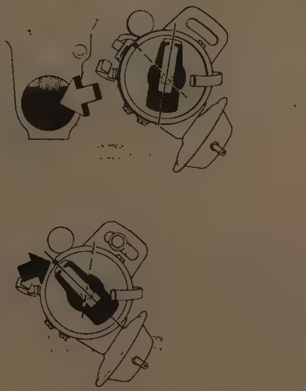
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Fig. 7 When installing the distributor, back the rotor clockwise to compensate for bevelled gears — B21, B23, B27 and B28 engines

utor is engaged, the rotor must align with the mark made prior to removal.

7. If the engine was disturbed after the distributor was removed, remove the spark plug for No. 1 cylinder and put your finger over the plug hole while you turn the engine over by hand. When you start to feel air pressure push against your finger, it means the cylinder is coming up on its compression stroke. With the engine on this compression stroke, turn the crankshaft around until the TDC mark on the harmonic balancer aligns with the timing pointer on the front of the engine. Install the distributor as explained in paragraph 2 of Step 6.

8. Connect the primary lead to its terminal on the distributor housing. On electronic fuel injected models, connect the plug for the triggering contacts. On 1975 and later models equipped with electronic ignition, push the primary voltage wire connector into its slot in the distributor housing and tighten the retaining screw.

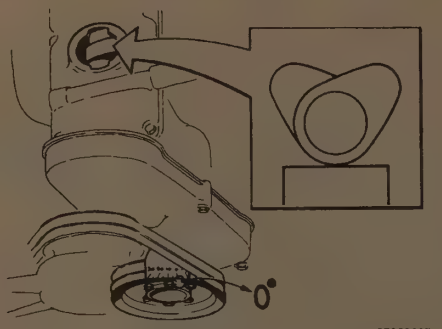


Fig. 8 Alternative method to install the distributor: remove the oil cap, then manually turn the crankshaft until the cam lobes for the No. 1 cylinder are as shown, then align the 0° mark with the pulley notch

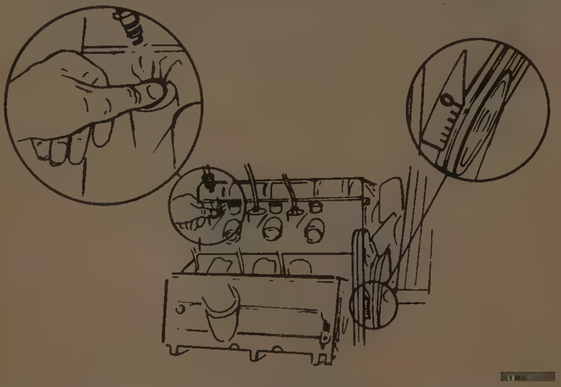


Fig. 9 Conventional method to install the distributor: remove the spark plug, manually turn the crankshaft. When you feel air pressure on your finger, align the timing marks

9. Connect the vacuum hose(s) to the connection(s) on the vacuum regulator, (if so equipped)

10. If the distributor was disassembled, or if the contact point setting was disturbed on models so equipped, proceed to set the point gap and/or dwell angle.

11. Install the distributor cap and secure the clasps. Start the engine and set the ignition timing. See Section 2. Tighten the distributor attaching screw.

DIESEL ENGINE

Checking the Glow Plugs

➧ See Figure 10

1. With the engine cold, connect a test light between the glow plug terminal and ground.

2. Have an assistant sit in the car and turn on the ignition key to **ON** (not **START**) and observe the glow plug light on the dash board:

   a. If the glow plug light does not light and the test light does not light, it indicates a failure at the control unit.

   b. If the glow plug light does light but the test light does not, it indicates a failure at the glow plug relay.

   c. If the glow plug light does not light but the test light does, it indicates a failure at the temperature sender or at the control unit.

3. Turn the ignition key to its 0 (off) position and remove the flat bar connector between the glow plug terminals. Connect a test light between the positive battery terminal and each glow plug terminal. If the test light does not light, it indicates a faulty glow plug.

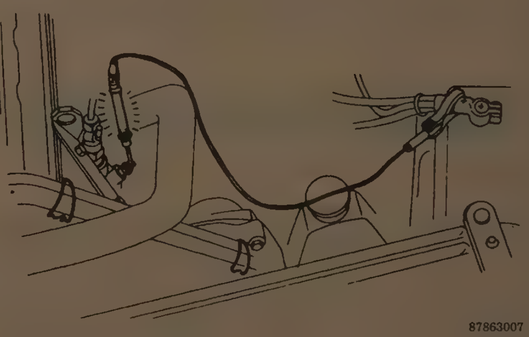


Fig. 10 Use a test light as shown to assist in diagnosing possible faults in the power flow to the glow plugs

Alternator

PRECAUTIONS

Several precautions must be observed when performing work on alternator equipment.

1. If the battery is removed for any reason, make sure that it is reconnected with the correct polarity. Reversing the battery connections may result in damage to the one-way rectifiers.
2. Never operate the alternator with the main circuit broken. Make sure that the battery, alternator, and regulator leads are not disconnected while the engine is running.
3. Never attempt to polarize an alternator.
4. When charging a battery that is installed in the vehicle, disconnect the negative battery cable.
5. When utilizing a booster battery as a starting aid, always connect it in parallel; negative to negative, and positive to positive.
6. When arc (electric) welding is to be performed on any part of the vehicle, disconnect the negative battery cable, disconnect the alternator leads, and unplug the voltage regulator.
7. Never unplug any ECU, computer or "black box" while the engine is running or the ignition is **ON**. Severe and expensive damage may result within the solid state equipment.

REMOVAL & INSTALLATION

➡On some models, it will be necessary to remove the air pump and place it to one side to gain access to the alternator.

1. Disconnect the negative battery cable.
2. Disconnect the electrical leads to the alternator.
3. Remove the adjusting arm-to-alternator bolt and adjusting arm-to-engine bolt.
4. Remove the alternator-to-engine mounting bolt.
5. Remove the fan belt and lift the alternator forward and out.
6. Reverse the above procedure to install, taking care to properly tension the fan (drive) belt as outlined in the Routine Maintenance portion of Section 1.

Voltage Regulator

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Disconnect the leads or plug socket from the old regulator taking note of their (its) location.
3. Remove the hold-down screws from the old regulator and install the new one.
4. Connect the leads or plug socket and reconnect the negative battery cable.

VOLTAGE ADJUSTMENT

Motorola (S.E.V. Marchal) Regulator

➧ See Figures 11, 12 and 13

If the Motorola A.C. Regulator is found to be defective, it must be replaced. No adjustments can be made on this unit.

The following test may be performed on the Motorola regulator to see if it is functioning properly. Am ammeter, tachometer, and voltmeter are required. Note that the ammeter circuit commonly found on a volt/ohmmeter (VOM) is for very small amperages and is NOT sufficient for this test. An ammeter reading to at least 75 amperes is required.

1. Connect the test equipment to the alternator and regulator as shown in the illustration.
2. Run the engine at 2500 rpm (5000 alternator rpm) for 15 seconds. With no load on the alternator, (all electrical equipment turned off) and the regulator ambient temperature at 77°F (25°C), the reading on the voltmeter should be 13.1-14.4 volts. For regulator ambient temperatures other than 77°F (25°C), consult the voltage-temperature diagram for cold regulator.
3. Load the alternator with 10-15 amps (high beam headlights) while the engine is running at 2500 RPM. The voltmeter reading should again be 13.1-14.4 V Replace the regulator if it does not fall within these limits.
4. For a more accurate indication of the regulator's performance, drive the vehicle for about 45 minutes at a minimum speed of 30 mph. The regulator will be at the correct working temperature immediately after this drive.
5. With the engine running at 2500 rpm and the regulator ambient temperature at 77°F (25°C), the voltmeter reading should be 13.85-14.25 V For regulator ambient temperatures other than 77°F (25°C), consult the voltage-temperature diagram for warm regulator.

Bosch Regulator (35, 55, 70 amp)

➧ See Figures 14 and 15

The Bosch regulator is fully adjustable. To determine which adjustments are necessary (if any) perform the following test.

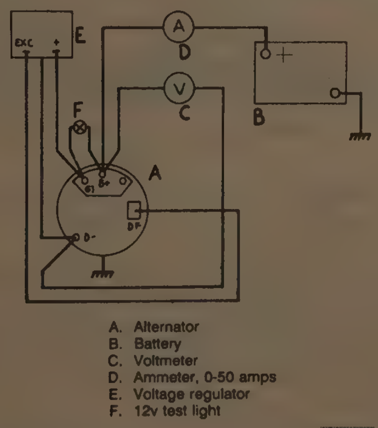


Fig. 11 Wiring diagram for testing the Motorola regulator

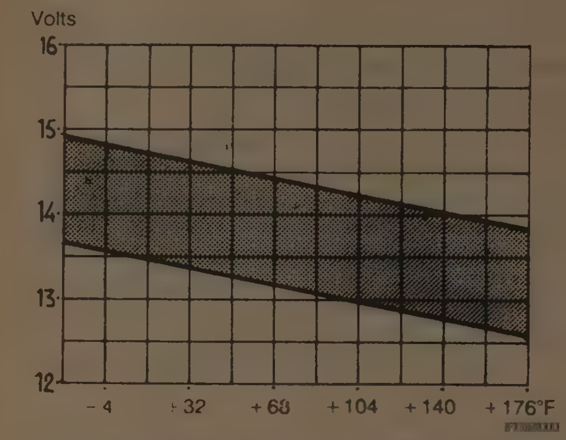


Fig. 12 Voltage/temperature diagram for a cold regulator

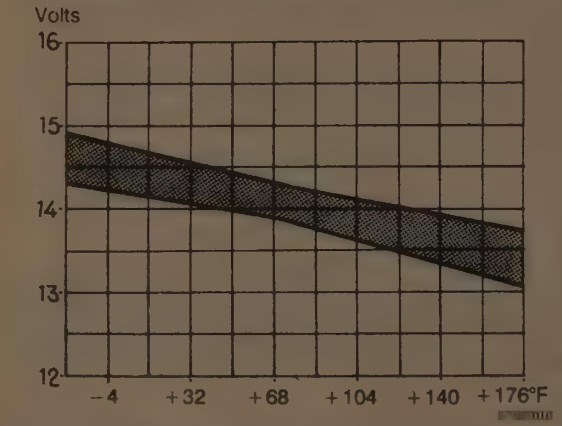


Fig. 13 Voltage/temperature diagram for a warm regulator

An ammeter, 12 V test lamp, tachometer, and voltmeter are required for this test.

➡Where the numerical values differ for the 35 amp voltage regulator and the 55 amp unit, the figures for the 55 amp regulator will be given in parentheses.

1. Connect the alternator and regulator shown in the illustration.

➡The first reading must be taken within 30 seconds of beginning of test.

2. While running the engine at 2000 rpm, load the alternator with 28-30 amps (44-46 for 55 amp alternator).
3. Rapidly lower the engine to idle speed or 500 rpm and then return it to 2000 rpm. With a load of 28-30 amp (44-46 for 55 amp alternator), the voltmeter reading should be 14.0-15.0 V (13.9-14.8 V for 55 amp alternator). The regulator should be regulated on the left (lower) contact.
4. Reduce the alternator load to 3-8 amps. The voltmeter reading should not decrease more than 0.3 V. (0.4 for 55 amp alternator) The regulator should be regulated on the right (upper) contact.
5. Adjustment is made by bending the stop bracket for the bimetal spring. Bending the stop bracket down lowers the regulating voltage; bending it up raises the voltage. If the voltmeter reading for the low amp alternator load decreased more than 0.3 V. (0.4 for 55 amp alternator) compared to the reading for the high amp alternator load, adjust the regulator by bending the holder for the left (lower) contact and simultaneously adjust the gap between the right (upper) contact and the movable contact. The gap should be adjusted to 0.010-0.015 in. (0.25-0.40mm). If the holder is bent toward the right (upper) contact, the regulating voltage under high amp alternator load will be lowered. To avoid faulty adjustments due to residual magnetism in the regulator core, it may be necessary to rapidly lower the engine rpm to idle after each adjustment, and then raise it to 2000 rpm to take a new reading.

➡Warm regulators may be cooled to ambient temperature by directing a stream of compressed air on them. Final readings should be made with the regulator at ambient temperature.

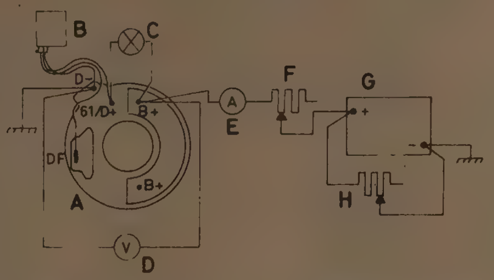
1983 and newer Bosch alternators use an integrated voltage regulator. This device is mounted directly on the back of the alternator. Due to its solid state construction, no internal testing or adjustment is possible.

The function of this type of regulator can be simply tested with a voltmeter in the following fashion:

6. Connect voltmeter between terminals B+ and D on the alternator. DO NOT disconnect any other wires on these terminals when testing.
7. Have an assistant start the engine and accelerate it to 3000 rpm and apply the specified electrical load. For an alternator rated at 55 amps, apply a 47 amp load. For a 70 amp alternator, apply 60 amps and for a 90 amp alternator apply a 77 amp load. This load tests the alternator at 85 percent of its rated output.
8. If the regulator is cold (77°F/25°C) and the reading is taken within one minute of start-up, the correct voltage should be 14.4-14.8 V for 1983 and 1984 models. 1985 and later models should show 14.1-14.9 V.
9. Under hot regulator conditions (car has been driven at least 15 minutes) the test voltages should now be between 0 and 0.3v lower than the cold test above.
10. Any readings outside these limits (either over or under) require the replacement of the regulator. This is done with the engine off by unplugging the connector (if there is one) and removing the two mounting bolts which hold the regulator.

✲✲WARNING

When removing the regulator, a set of alternator brushes will come out with it. Don't lose any small parts. Reinstall carefully, paying attention to proper brush placement and seating within the alternator.



A. Alternator
B. Voltage lamp 12 volts
C. Control lamp 12 volts, 2 watts
D. Voltmeter 0–20 volts
E. Ammeter 0–50 amps
F. Regulator resistance
G. Battery
H. Load resistance

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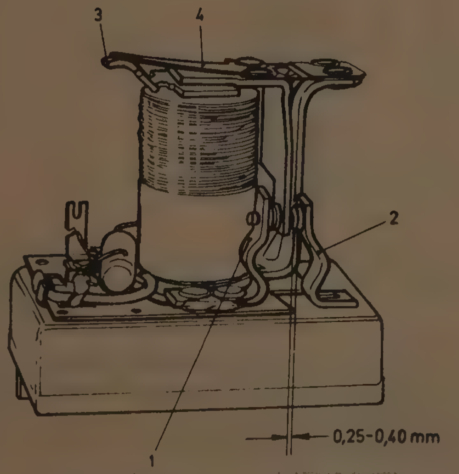
Fig. 14 Wiring diagram for testing the Bosch regulator



1. Regulator contact for lower control range (lower contact)
2. Regulator contact for upper control range (upper contact)
3. Spring tensioner
4. Spring upper section: Steel spring Lower section: Bimetal spring

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Fig. 15 Component legend for the adjustable Bosch voltage regulator

Battery

REMOVAL & INSTALLATION

1. Remove the positive and negative cables from their terminals on the top of the battery. If the cables remain stuck to the terminals after loosening the cable clamps, use a puller to free them. Do not try to pry the cables off the terminals; damage to the battery case and/or the terminals may result.
2. Remove the battery hold-down bar and lift out the battery. Keep the battery upright to avoid spilling acidic electrolyte.
3. Clean the battery case and support shelf with a brush and rinse with clean, lukewarm water. Remove any deposits from the terminals and cable ends with a wire brush or battery terminal tool.
4. Replace the battery on its support shelf and install the hold-down bar.
5. Install the cables in their proper terminals and tighten the clamps. Coat the exposed metal of the cables and terminals with petroleum jelly to prevent corrosion.

Starter

REMOVAL & INSTALLATION

➧ **See Figures 16 and 17**

1. Disconnect the negative battery cable.
2. Disconnect the leads from the starter motor. On later model cars, it may be necessary to loosen or remove other components to gain access to the starter bolts.
3. Remove the bolts retaining the starter motor brace to the cylinder block (B21 through 1977 only) and the bolts retaining the starter motor to the flywheel housing and lift it off.
4. To reinstall, position the starter motor to the flywheel housing. Apply locking compound to the bolt threads and in-

Alternator and Regulator Specifications

		Alternator			Regulator	
Year	Vehicle Model	Part No. and Manufacturer	Output (amps.)	Min. Brush Length (in.)	Part No. and Manufacturer	Volts @ Alternator rpm (cold)
1970	140	S.E.V. Motorola 14V 26641	35	0.20	S.E.V. Motorola 14V 33525	13.1–14.4 @ 4000
1970–71	140, 1800	Bosch K1 14V 35A20	35	0.31	Bosch AD 14V	14.0–15.0 @ 4000
1970–75 1972–74	164 140, 1800	S.E.V. Motorola 14V 34833	55	0.20	S.E.V. Motorola 14V 33544	13.1–14.4 @ 4000
1971 1971–72	1800 140	S.E.V. Motorola 14V 71270202	35	0.20	S.E.V. Motorola 14V 33525	13.1–14.4 @ 4000
1972–73	1800	Bosch K1 14V 55A20	55	0.53	Bosch AD 14V	13.9–14.8 @ 4000
1975–83	240, DL, GL, GT, 760 GLE	Bosch 14V 55A20	55③	0.20	Bosch	13.5–14.1 @ 4000①
1976–82	260, GLE, Coupe	S.E.V. Marchal A14/55A 7160410	55②	0.20	S.E.V. Marchal 72710502	13.5–14.1 @ 4000①
1983	DL, GL, 760 GLE, GLT, DL, Turbo	Bosch N114V 70A20	70	0.20	Bosch 0197311008	14.4–14.8 @ 6000①
1983	760 GLE	Bosch N114V 90A20	90	0.20	Bosch④ 0192052027	14.1–14.8 @ 3000①
1984	240 Diesel 4 DL⑤	Bosch K114V 55A20	55	0.20	Bosch 0120489066⑥	14.4–14.8 @ 3000
	240 DL (US) GL, GLE Turbo 760 GLE Gas & Diesel	Bosch N114V 70A20	70	0.20	Bosch 0120469568	14.4–14.8 @ 3000
1985–89	DL & GL	Bosch N114V 70A20	70	0.20	Bosch 0120469568	14.4–14.8 @ 3000
	85-Turbo	Bosch N114V 31/80A	80	0.20	Bosch 0120429787	14.1–14.8 @ 6000
85–89	740, 760, 780	Bosch K114V 55A20	55	0.20	Bosch 0120489066	14.4–14.8 @ 3000
		Bosch N114V 70A20	70	0.20	Bosch 0120469568	14.4–14.8 @ 3000
		Bosch N114V 31/80A	80	0.20	Bosch 0120 429 787	14.1–14.8 @ 6000
		Bosch N114V 90A20	90	0.20	Bosch 0192052027	14.1–14.8 @ 6000
		Bosch N114V 31/100A	100	0.20	Bosch 13634977⑦	14.1–14.9 @ 6000

① After driving 10 minutes
② 1979–82: 70
③ 1982 B21F Turbo rated output 770W; max. current 55A
④ Early type; late type Bosch 1197311008
⑤ Canada only
⑥ Diesel: 0120489070
⑦ '88 760: 13635107

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stall the retaining bolts finger-tight. Tighten the bolts to approximately 25 ft. lbs. (34 Nm).

5. Connect the starter motor leads and the negative battery cable.

DRIVE REPLACEMENT

➧ See Figures 18, 19, 20, 21, 22 and 23

In order to remove the starter pinion drive, it is necessary to disassemble the starter. The procedure for disassembling the starter is as follows:

1. Remove the starter from the car.
2. Unscrew the two screws and remove the small cover from the front end of the starter shaft.
3. Unsnap the lockwasher and remove the adjusting washer from the front end of the shaft.
4. Unscrew the two screws retaining the commutator bearing shield and the shield.
5. Lift up the brushes and retainer and remove the brush bridge from the rotor shaft. The negative brushes are removed with the bridge while the positive brushes remain in the field winding. Do not remove the steel washer and the fiber washer at this time.
6. Unscrew the nut retaining the field terminal connection to the control solenoid.
7. Unscrew the two solenoid-to-starter housing retaining screws and remove the solenoid.
8. Remove the drive end shield and rotor from the stator.
9. Remove the rubber and metal sealing washer from the housing.
10. Unscrew the nut and remove the screw on which the engaging arm pivots.
11. Remove the rotor, with the pinion and engaging arm attached, from the drive end shield.
12. Push back the stop washer and remove the snapring from the rotor shaft.

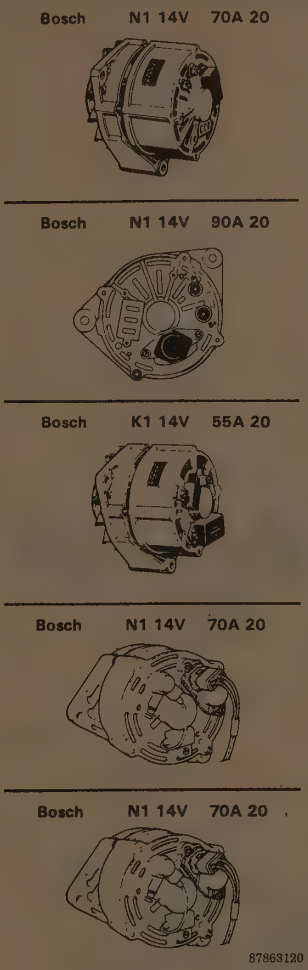
Bosch N1 14V 70A 20
Bosch N1 14V 90A 20
Bosch K1 14V 55A 20
Bosch N1 14V 70A 20
Bosch N1 14V 70A 20
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Fig. 16 Examples of alternators with internal regulators — amperage ratings appear on a plate on the alternator case

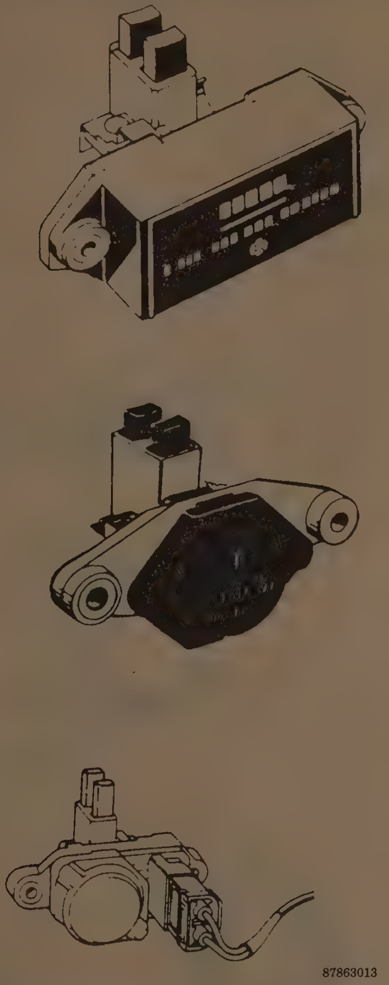

Fig. 17 Examples of integrated voltage regulators found on 1983 and later Volvos

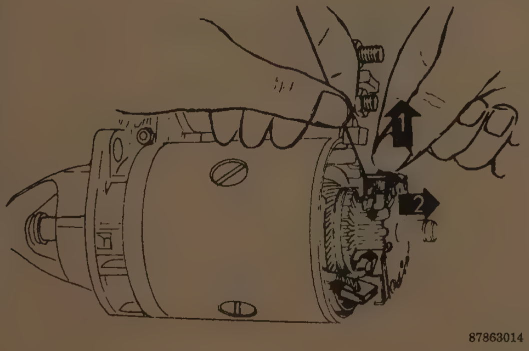
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Fig. 18 Lift up the brushes and remove the brush bridge

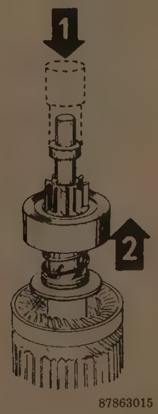
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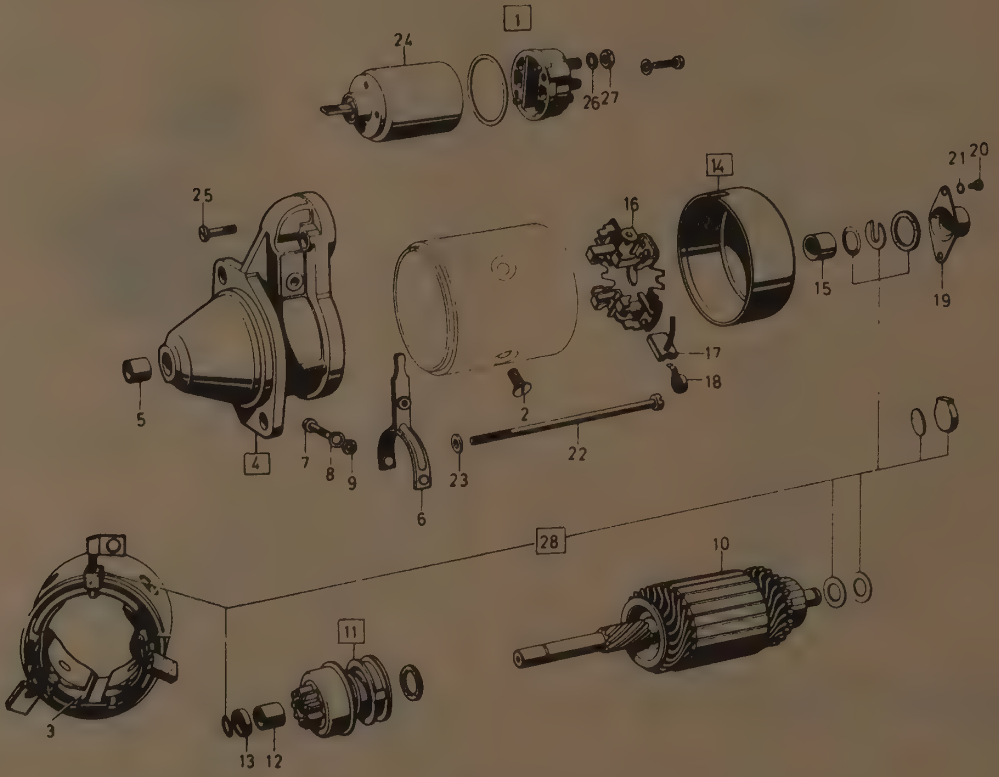
Fig. 19 Use a socket to push back the stop collar and remove the snap-ring to remove the starter drive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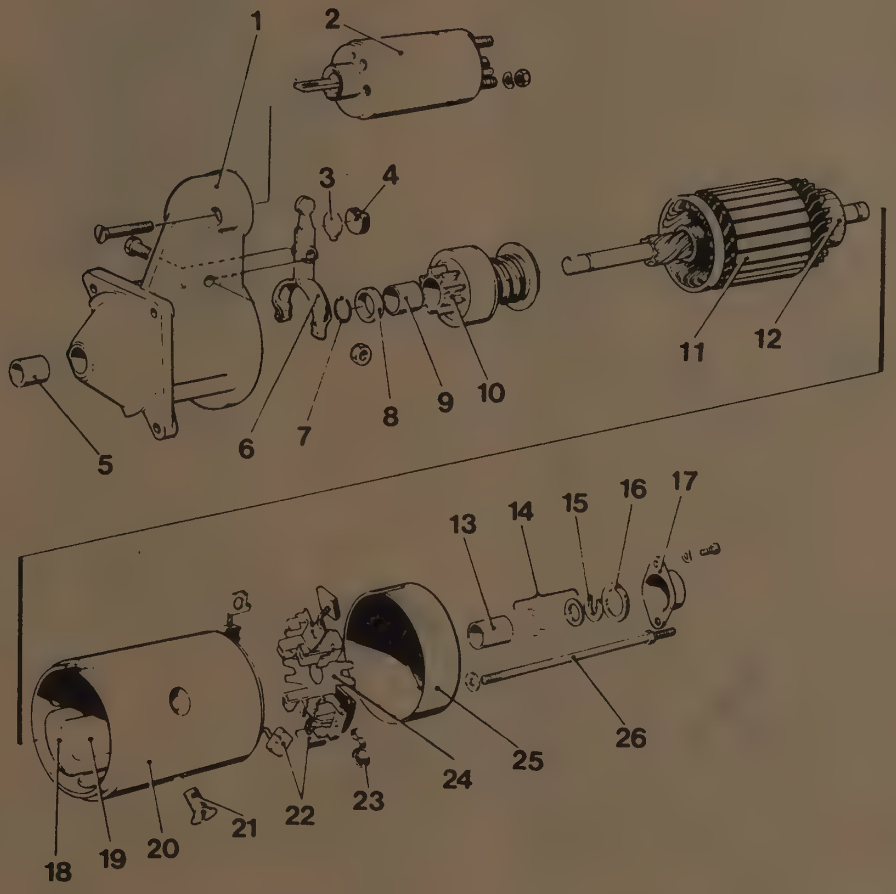
1. Solenoid
2. Screw
3. Field housing
4. Drive housing
5. Bushing
6. Engagement lever
7–9. Screw, washer and nut
10. Armature
11. Starter drive
12. Bushing
13. Stop collar
14. Brush cover
15. Bushing
16. Brush holder
17. Brush
18. Brush tension spring
19–21. Cap
22. Through bolt
23. Washer
24. Solenoid housing
25. Screw
28. Washers and pads

Fig. 20 Exploded view of the starter motor — common to all models through 1984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1. Drive end bearing housing
2. Solenoid
3. Steel washer
4. Rubber washer
5. Bushing
6. Shift arm
7. Snap-ring
8. Stop ring
9. Spacer bushing
10. Drive
11. Armature
12. Commutator
13. Bushing
14. Shims
15. Lock washer
16. Sealing ring
17. Bushing cap
18. Field coil
19. Pole shoe
20. Starter body
21. Pole screw
22. Carbon brush
23. Brush spring
24. Brush holder
25. Bushing cover
26. Rod

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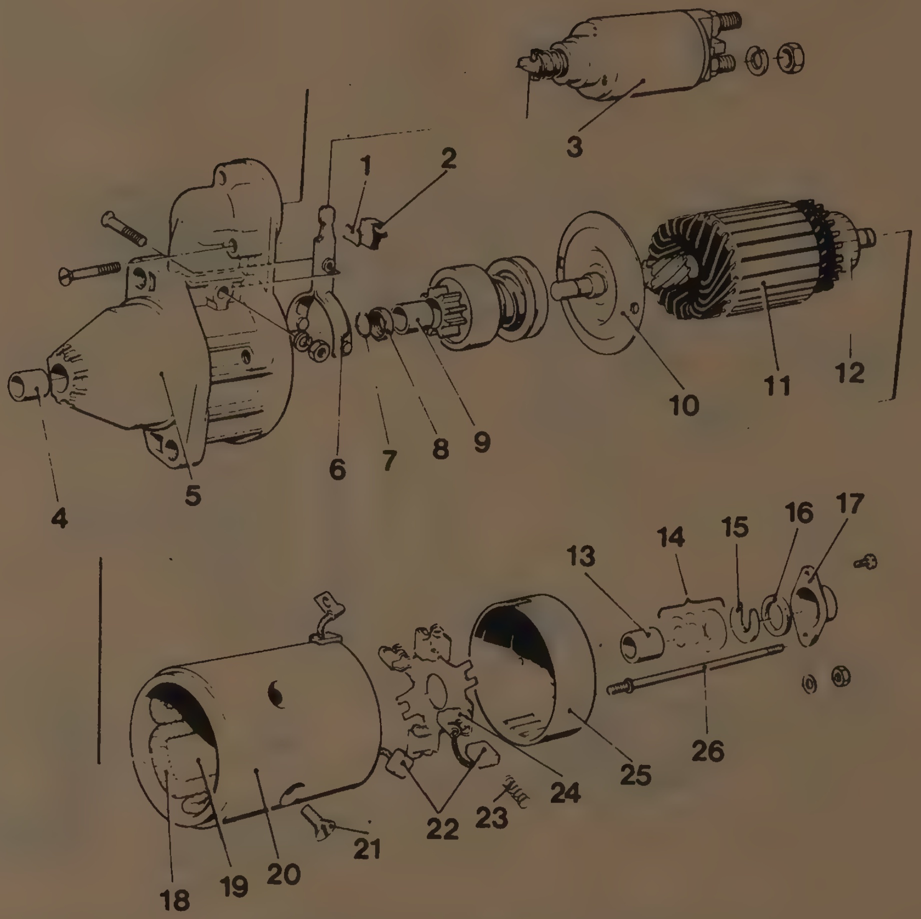
Fig. 21 Exploded view of the starter motor — B28F and B280F engines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1. Steel washer
2. Rubber washer
3. Solenoid
4. Drive end bearing housing
5. Bushing
6. Shift arm
7. Snap-ring
8. Stop ring
9. Bushing
10. Center bearing
11. Armature
12. Commutator
13. Bushing
14. Shims
15. Lock washer
16. Sealing ring
17. Bushing cap
18. Field coil
19. Pole shoe
20. Starter body
21. Screw
22. Brush
23. Brush spring
24. Brush holder
25. Bushing cover
26. Rod

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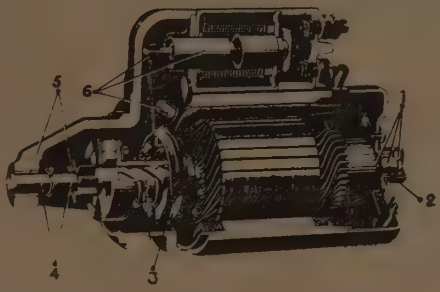
Fig. 22 Exploded view of the starter motor — D24 and D24T engines



1. Place a thin layer of grease on the insulation washers, the shaft end, the adjusting washers and lock washer.
2. Place the bushing in oil for one hour before installing.
3. Apply plenty of grease in the rotor thread and the engaging lever groove.
4. Lightly grease the armature shaft.
5. Place the bushings in oil for one hour before installing.
6. Lightly grease the lever joints and the iron core of the solenoid.

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Fig. 23 Lubricate the starter motor as described upon reassembly

13. Remove the stop washer and pull off the starter pinion.

➡While the starter is disassembled, a few quick checks may be performed. Check the rotor shaft, commutator, and windings. If the rotor shaft is bent or worn, it must be replaced. Maximum rotor shaft radial throw is 0.003 in. (0.08mm). If the commutator is scored or worn unevenly, it should be turned by a machine shop. Minimum commutator diameter is 1.3 in. (33mm). Check the end shield, which houses the brushes, for excessive wear. Maximum bearing clearance is 0.005 in. (0.13mm).

14. Lubricate the starter.
15. Press the starter pinion onto the rotor shaft. Install the stop washer and secure it with a new snapring.
16. Position the engaging arm on the pinion. Install the rotor into the drive end frame.
17. Install the screw and nut for the engaging arm pivot.
18. Install the rubber and metal sealing washers into the drive end housing.
19. Install the stator onto the rotor and drive end shield.
20. Position the solenoid so that the eyelet on the end of the solenoid plunger fits onto the engaging arm (shift lever). Tighten the solenoid retaining screws.
21. Place the metal and fiber washers on the rotor shaft.
22. Install the brush bridge on the rotor shaft and replace the brushes.
23. Fit the commutator bearing shield into position and install the retaining screws.
24. Install the adjusting washers and snap a new lockwasher into position on the end of the shaft. Make sure that the rotor axial clearance does not exceed 0.12 in. (0.03mm). If necessary, adjust the clearance with washers, maintaining a minimum clearance of 0.012 in. (0.05mm).
25. Replace the small cover over the front end of the shaft and install the two retaining screws.
26. Install the starter in the car.

SOLENOID REPLACEMENT

If the starter will not crank, before replacing the solenoid check the battery for sufficient charge. If the no-crank condition persists when the battery is known to be good, connect a jumper wire between the positive terminal of the battery and the contact screw for the solenoid lead. If the solenoid engages the starter pinion, the starter switch or leads are at fault. If the starter still does not crank, replace the solenoid. To remove the solenoid:

1. Remove the starter from the car as outlined in Starter Removal and Installation.
2. Unscrew the two solenoid-to-starter housing retaining screws and remove the solenoid.
3. As a final test, wipe the solenoid clean and press in the armature. Test its operation by connecting it to a battery. If the solenoid still does not function, replace it with a new unit.
4. Position the new solenoid so that the eyelet on the end of the plunger fits into the engaging arm. Tighten the retaining screws.
5. Replace the starter in the car as outlined in Starter Removal and Installation.

Battery and Starter Specifications

All cars use 12 volt, negative ground electrical systems

			Starter							
			Lock Test			No Load Test				
Year	Model	Battery Amp Hour Capacity	Amps	Volts	Torque (ft. lbs.)	Amps	Volts	RPM	Brush Spring Tension (lbs.)	Min. Brush Length (in.)
All	140 Series, 164, 180	60	300–350	6	—	40–50	12	6900–8100	2.53–2.86	0.60
All ③	240 Series, 260 Series, GL, GT, DL, GLT, Turbo, 740 GLE, Coupe, 760 GLE, 780	60 ①	400–490	7	—	30–50	11.5	5800–7800	3.10–3.50	0.52
All ③	D24, D24T Diesel	88 ②	700–880	7	—	65–95	11.5	6500–8500	5.10–5.50	0.35
'84	760 GLE	450 ④	480–560	7.4	—	max 70	11.5	7500	4.0–4.8	0.41
'85	740 GL, GLE Turbo, All 760	450 ④	480–560	7.4	—	max 70	11.5	7500	4.0–4.6	0.51
	D24T	450	700–880	4.5	—	max 95	11.5	7500	5.0–6.0	0.51
'86	760 GLE, Turbo	450 ④	700–880	4.5	—	max 95	11.5	7500	5.0–6.0	0.51
'88	740, 760, 240	450 ④	650 ⑥	6.0	—	max 60	12.0	7000	2.5–3.8	0.43
'89	240	450 ④	625–800	4.5	—	max 75	11.5	2900	3.5–4.8	0.31
'89	740, 760 Turbo, 780	500 ⑤	Bosch 700–800	4.5	—	max 95	11.5	6500	5–6	0.33
			Hitachi max 880	3.0	—	max 140	11.0	3900	6.0–7.8	0.35

① 260 series, GLE, Coupe—70 amp hour battery
② 90 amp hour High Output
③ Except below.
④ 90 minutes
⑤ 90 min; exc 780, 110 min.
⑥ Hitachi starter

87853C05

Troubleshooting Basic Charging System Problems

Problem	Cause	Solution
Noisy alternator	• Loose mountings • Loose drive pulley • Worn bearings • Brush noise • Internal circuits shorted (High pitched whine)	• Tighten mounting bolts • Tighten pulley • Replace alternator • Replace alternator • Replace alternator
Squeal when starting engine or accelerating	• Glazed or loose belt	• Replace or adjust belt
Indicator light remains on or ammeter indicates discharge (engine running)	• Broken fan belt • Broken or disconnected wires • Internal alternator problems • Defective voltage regulator	• Install belt • Repair or connect wiring • Replace alternator • Replace voltage regulator
Car light bulbs continually burn out—battery needs water continually	• Alternator/regulator overcharging	• Replace voltage regulator/alternator
Car lights flare on acceleration	• Battery low • Internal alternator/regulator problems	• Charge or replace battery • Replace alternator/regulator
Low voltage output (alternator light flickers continually or ammeter needle wanders)	• Loose or worn belt • Dirty or corroded connections • Internal alternator/regulator problems	• Replace or adjust belt • Clean or replace connections • Replace alternator or regulator

87853C04

Troubleshooting Basic Starting System Problems

Problem	Cause	Solution
Starter motor rotates engine slowly	• Battery charge low or battery defective	• Charge or replace battery
	• Defective circuit between battery and starter motor	• Clean and tighten, or replace cables
	• Low load current	• Bench-test starter motor. Inspect for worn brushes and weak brush springs.
	• High load current	• Bench-test starter motor. Check engine for friction, drag or coolant in cylinders. Check ring gear-to-pinion gear clearance.
Starter motor will not rotate engine	• Battery charge low or battery defective	• Charge or replace battery
	• Faulty solenoid	• Check solenoid ground. Repair or replace as necessary.
	• Damage drive pinion gear or ring gear	• Replace damaged gear(s)
	• Starter motor engagement weak	• Bench-test starter motor
	• Starter motor rotates slowly with high load current	• Inspect drive yoke pull-down and point gap, check for worn end bushings, check ring gear clearance
	• Engine seized	• Repair engine
Starter motor drive will not engage (solenoid known to be good)	• Defective contact point assembly	• Repair or replace contact point assembly
	• Inadequate contact point assembly ground	• Repair connection at ground screw
	• Defective hold-in coil	• Replace field winding assembly
Starter motor drive will not disengage (cont.)	• Starter motor loose on flywheel housing	• Tighten mounting bolts
	• Worn drive end busing	• Replace bushing
	• Damaged ring gear teeth	• Replace ring gear or driveplate
	• Drive yoke return spring broken or missing	• Replace spring
Starter motor drive disengages prematurely	• Weak drive assembly thrust spring	• Replace drive mechanism
	• Hold-in coil defective	• Replace field winding assembly
Low load current	• Worn brushes	• Replace brushes
	• Weak brush springs	• Replace springs

ENGINE MECHANICAL

Four basic gasoline engine families and the diesel/turbo diesel are covered in this book.

The B20, the B30, the B21/B23/B230/B234 and the B27/B28/B280. The 4-cylinder, 1999cc B20 and the 6-cylinder, 2980cc B30 are both based on the same inline, overhead valve design. The B21 (2127cc) is an overhead camshaft engine with a cast iron block and an aluminum, cross flow head (intake and exhaust manifolds are on separate sides of the head). The B23 (2320cc), which is very similar to the B21 series, but has a bigger bore and a new block design. The B230 series, introduced in 1985, is a further refinement of the B23.Lighter pistons and pins, low-friction rings and assorted other modifications to increase economy and reduce vibration.

The B27 and its 1980 version, the B28, are 90° V6 engines with aluminum alloy blocks and heads. Both engines are basically the same. The B28's cylinder displacement (2849cc) is larger than the B27's (2664cc). Many parts on the B28 have been redesigned and, therefore, cannot be exchanged with B27 parts. Each cylinder head of the B27/B28 is equipped with a single overhead camshaft which is chain driven from the crankshaft. The block is fitted with cast iron cylinder liners. The B280 features improved oil cooling, cam-driven distributor, and redesigned manifolds with swirl chamber intakes.

The B234 engine was introduced in the late 1988 740 GLE. This 16 valve twin camshaft engine is the B230 with a different head and valve layout. Its sophisticated design allows it to deliver more power more smoothly. It incorporates two balance shafts on the side of the block to damp out harsh engine vibration. These shafts are belt driven, as are the two camshafts.

The inline 6-cylinder diesel engine, the D24, used by Volvo is built by Volkswagen and is fundamentally the same as the engine for the Audi 5000 except, of course, for the extra cylinder tacked on at the end. The cylinder block is cast iron while the head is aluminum alloy. The overhead camshaft is driven by a belt at the front of the engine and in turn drives the fuel injection pump via a belt at the back of the engine. The D24T is a turbocharged variant of the D24 and shares most of the design features.

Engine Overhaul Tips

Most overhaul procedures for gasoline and diesel engines are fairly standard. In addition to specific parts replacement procedures and complete specifications for each individual engine, this section is also a guide to acceptable rebuilding procedures. Examples of standard rebuilding practice are shown and should be used along with specific details concerning your particular engine.

Competent and accurate machine shop services will insure maximum performance, reliability and engine life. In most instances, it is more profitable for the do-it-yourself mechanic to remove, clean and inspect the component, buy the necessary parts and deliver these to a shop for actual machine work.

On the other hand, much of the assembly work (crankshaft, block, bearings, piston rods, and other components) is well within the scope of the do-it-yourself mechanic.

TOOLS

The tools required for an engine overhaul or parts replacement will depend on the depth of your involvement. With few exceptions, they will be the tools found in any mechanic's tool kit (see Section 1). More in-depth work will require some or all of the following:

- dial indicator (reading in thousandths) mounted on a universal base
- micrometers and telescope gauges
- jaw and screw-type pullers
- scraper
- valve spring compressor
- ring groove cleaner
- piston ring expander and compressor
- ridge reamer
- cylinder hone or glaze breaker
- Plastigage®
- engine stand

The use of most of these tools is illustrated in this section. Many can be rented for a one-time use from a local parts jobber or tool supply house specializing in automotive tools. Occasionally, the use of special tools is called for. See the information on Special Tools and Safety Notice in the front of this book before substituting another tool.

INSPECTION TECHNIQUES

Procedures and specifications are given in this section for inspecting, cleaning and assessing the wear limits of most major components. Other procedures such as Magnaflux® and Zyglo® can be used to locate material flaws and stress cracks. Magnaflux® is a magnetic process applicable only to ferrous (iron containing) materials. The Zyglo® process coats the material with a fluorescent dye penetrate and can be used on any material Check for suspected surface cracks can be more readily made using spot check dye. The dye is sprayed onto the suspected area, wiped off and the area sprayed with a developer. Cracks will show up brightly.

OVERHAUL NOTES

Aluminum has become extremely popular for use in engines, due to its low weight. Observe the following precautions when handling aluminum parts:

- Never hot tank aluminum parts; the caustic hot-tank solution will eat the aluminum.
- Remove all aluminum parts (identification tag, etc.) from engine parts prior to the tanking.
- Always coat threads lightly with engine oil or anti-seize compounds before installation, to prevent seizure.
- Never over-torque bolts or spark plugs, especially in aluminum threads.

When assembling the engine, any parts that will be in frictional contact must be pre-lubed to provide lubrication at initial start-up. Any product specifically formulated for this purpose can be used, but engine oil is not recommended as a prelube.

When semi-permanent (locked, but removable) installation of bolts or nuts is desired, threads should be cleaned and coated with Loctite® or other similar, commercial non-hardening sealant.

REPAIRING DAMAGED THREADS

➧ See Figures 24, 25, 26, 27 and 28

Several methods of repairing damaged threads are available. Heli-Coil® (shown here), Keenserts® and Microdot® are among the most widely used. All involve basically the same principle (drilling out stripped threads, tapping the hole and installing a pre-wound insert), making welding, plugging and oversize fasteners unnecessary.

Two types of thread repair inserts are usually supplied: a standard type for most Inch Coarse, Inch Fine, Metric Course and Metric Fine thread sizes and a spark lug type to fit most spark plug port sizes. Consult the individual manufacturer's catalog to determine exact applications. Typical thread repair kits will contain a selection of pre-wound threaded inserts, a tap (corresponding to the outside diameter threads of the insert) and an installation tool. Spark plug inserts usually differ because they require a tap equipped with pilot threads and a combined reamer/tap section. Most manufacturers also supply blister packed thread repair inserts separately in addition to a master kit containing a variety of taps and inserts plus installation tools.

Before effecting a repair to a threaded hole, remove any snapped, broken or damaged bolts or studs. Penetrating oil can be used to free frozen threads. The offending item can be removed with locking pliers or with a screw or stud extractor. After the hole is clear, the thread can be repaired.

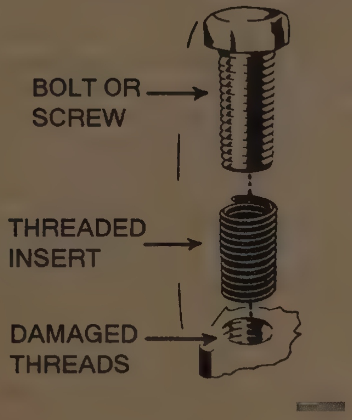

Fig. 24 Damaged bolt hole threads can be replaced with thread repair inserts

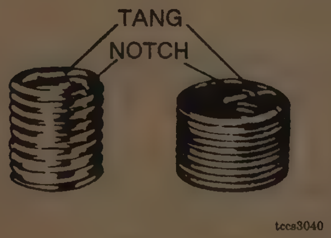

Fig. 25 Standard thread repair insert (left), and spark plug thread insert

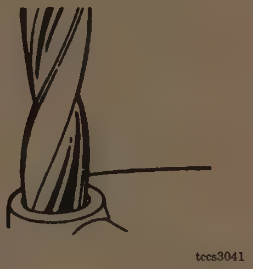

Fig. 26 Drill out the damaged threads with the specified drill. Be sure to drill completely through the hole or to the bottom of a blind hole

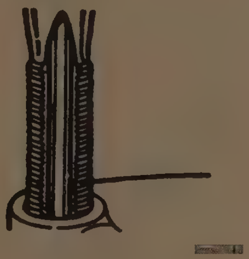

Fig. 27 Using the kit, tap the hole in order to receive the threaded insert. Keep the tap well-oiled and back it out frequently to avoid clogging the threads

CHECKING ENGINE COMPRESSION

Gasoline Engines

➧ See Figure 29

A noticeable lack of engine power, excessive oil consumption and/or poor fuel mileage measured over an extended period are all indicators of internal engine wear. Worn piston rings, scored or worn cylinder bores, blown head gaskets, sticking or burnt valves and worn valve seats are all possible culprits here. A check of each cylinder's compression will help you locate the problems.

As mentioned in the Tools and Equipment portion of Section 1, a screw-in type compression gauge is more accurate than the type that is simply held against the spark plug hole, although it takes slightly longer to use. It's worth it to obtain a more accurate reading. Follow the procedures below.

1. Warm up the engine to normal operating temperature.
2. Remove all spark plugs.

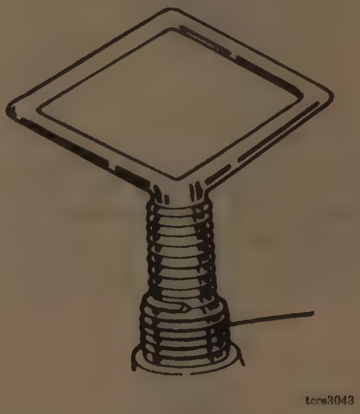

Fig. 28 Screw the threaded insert into the installer tool until the tang engages the slot. Thread the installer tool into the hole until it is ¼ or ½ turn below the top surface, then remove the tool and break off the tang using a punch.

Fig. 29 A screw-in type compression gauge is more accurate and easier to use without an assistant

3. Disconnect the primary lead from the ignition coil/module.
4. Disconnect all fuel injector electrical leads, if applicable.
5. Screw the compression gauge into the No. 1 spark plug hole until the fitting is snug.

➡Be careful not to crossthread the plug hole. On aluminum cylinder heads use extra care, as the threads in these heads are easily ruined.

6. Have an assistant depress the accelerator pedal fully. Then, while you read the compression gauge, ask the assistant to crank the engine two or three times in short bursts using the ignition switch.
7. Read the compression gauge at the end of each series of cranks, and record the highest of these readings. Repeat this procedure for each of the engine's cylinders. Compare the highest reading of each cylinder to the compression pressure specification in the Tune-Up Specifications chart in Section 2. The specs in this chart are maximum values.

A cylinder's compression pressure is usually acceptable if it is not less than 80% of maximum. The difference between any two cylinders should be no more than 12-14 pounds.

8. If a cylinder is unusually low, pour a tablespoon of clean engine oil into the cylinder through the spark plug hole and repeat the compression test. If the compression comes up after adding the oil, it appears that the cylinder's piston rings or bore are damaged or worn. If the pressure remains low, the valves may not be seating properly (a valve job is needed), or the head gasket may be blown near that cylinder. If compression in any two adjacent cylinders is low, and if the addition of oil doesn't help the compression, there is leakage past the head gasket. Oil and coolant water in the combustion chamber can result from this problem. There may be evidence of water droplets on the engine dipstick when a head gasket has blown.

Diesel Engines

➧ See Figures 30, 31 and 32

➡Special Volvo adapter (tool 5191) and a compression gauge which reads to at least 600 psi (4137 kPa) must be used to test the compression on the Volvo diesel.

Checking cylinder compression on diesel engines is basically the same procedure as on gasoline engines except that a special compression gauge adaptor suitable for diesel engines (because these engines have much greater compression pressures) must be used.

➡Don't forget to remove the washer underneath each injector. Otherwise, it may get lost when the engine is cranked.

1. Disconnect the wire at the stop valve on the fuel pump so that the pump will not spray fuel while the compression is being tested.
2. Unbolt and remove the vacuum pump and its plunger from the engine.
3. Clean all of the fuel delivery pipes and connections, then unbolt and remove the fuel delivery pipes from the fuel injection pump and the injectors. Plug all connections to prevent dirt from entering the fuel system.

4. Using a 17mm socket, remove the injectors. Remove the disc-like heat shields under the injectors otherwise they will blow out and be lost during the compression test.

5. Beginning with cylinder No. 1, fit the heat shield in place, screw in the adapter (Volvo tool 5191) and seal and tighten to 50 ft. lbs. (68 Nm).

6. Connect the compression tester to the adapter.

7. Crank the engine with the starter motor and read the compression pressure:

New engine: 485 psi (3345 kPa)
Minimum acceptable pressure: 400 psi (2760 kPa)
Maximum allowable difference between any two cylinders: 70 psi (485 kPa)

8. After reading the compression pressure for all six cylinders, install new washers under each of the injectors with their heat shields and torque them to 50 ft. lbs. (68 Nm). Install the heat shields as shown in the illustration.

9. Install the fuel delivery lines and torque their attachments to 18 ft. lbs. (24 Nm).

10. Re-connect the wire to the stop valve on the fuel injection pump and install the vacuum pump and its plunger. Ensure that the O-ring on the pump is in good condition.

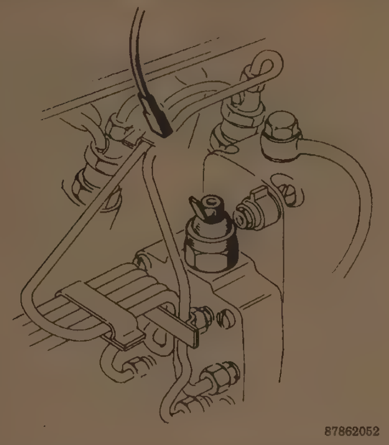

Fig. 30 Disconnect the wire at the stop valve on the fuel injection pump

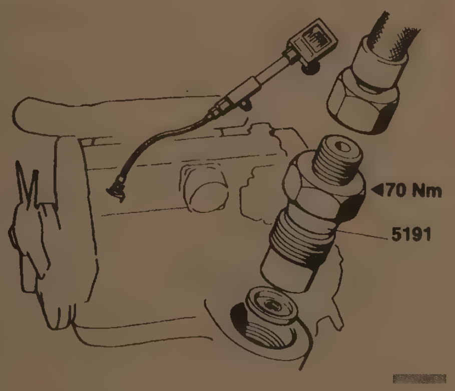

Fig. 31 Install the heat shield and adaptor, then the compression gauge

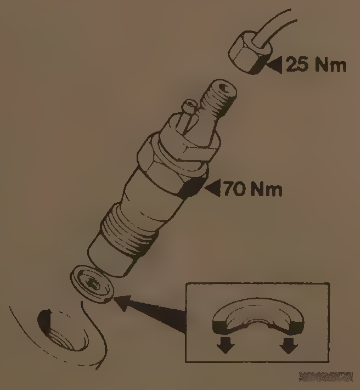

Fig. 32 Install the injectors making sure the heat shield is in the position shown

Troubleshooting Engine Mechanical Problems

Problem	Cause	Solution
External oil leaks	• Fuel pump gasket broken or improperly seated	• Replace gasket
	• Cylinder head cover RTV sealant broken or improperly seated	• Replace sealant; inspect cylinder head cover sealant flange and cylinder head sealant surface for distortion and cracks
	• Oil filler cap leaking or missing	• Replace cap
	• Oil filter gasket broken or improperly seated	• Replace oil filter
	• Oil pan side gasket broken, improperly seated or opening in RTV sealant	• Replace gasket or repair opening in sealant; inspect oil pan gasket flange for distortion
	• Oil pan front oil seal broken or improperly seated	• Replace seal; inspect timing case cover and oil pan seal flange for distortion
	• Oil pan rear oil seal broken or improperly seated	• Replace seal; inspect oil pan rear oil seal flange; inspect rear main bearing cap for cracks, plugged oil return channels, or distortion in seal groove
	• Timing case cover oil seal broken or improperly seated	• Replace seal
	• Excess oil pressure because of restricted PCV valve	• Replace PCV valve
	• Oil pan drain plug loose or has stripped threads	• Repair as necessary and tighten
	• Rear oil gallery plug loose	• Use appropriate sealant on gallery plug and tighten
	• Rear camshaft plug loose or improperly seated	• Seat camshaft plug or replace and seal, as necessary
	• Distributor base gasket damaged	• Replace gasket
Excessive oil consumption	• Oil level too high	• Drain oil to specified level
	• Oil with wrong viscosity being used	• Replace with specified oil
	• PCV valve stuck closed	• Replace PCV valve
	• Valve stem oil deflectors (or seals) are damaged, missing, or incorrect type	• Replace valve stem oil deflectors
	• Valve stems or valve guides worn	• Measure stem-to-guide clearance and repair as necessary
	• Poorly fitted or missing valve cover baffles	• Replace valve cover
	• Piston rings broken or missing	• Replace broken or missing rings
	• Scuffed piston	• Replace piston
	• Incorrect piston ring gap	• Measure ring gap, repair as necessary
	• Piston rings sticking or excessively loose in grooves	• Measure ring side clearance, repair as necessary
	• Compression rings installed upside down	• Repair as necessary
	• Cylinder walls worn, scored, or glazed	• Repair as necessary
	• Piston ring gaps not properly staggered	• Repair as necessary
	• Excessive main or connecting rod bearing clearance	• Measure bearing clearance, repair as necessary
No oil pressure	• Low oil level	• Add oil to correct level
	• Oil pressure gauge, warning lamp or sending unit inaccurate	• Replace oil pressure gauge or warning lamp
	• Oil pump malfunction	• Replace oil pump
	• Oil pressure relief valve sticking	• Remove and inspect oil pressure relief valve assembly
	• Oil passages on pressure side of pump obstructed	• Inspect oil passages for obstruction

87863C09

General Engine Specifications

Year	Engine Designation	Engine Displacement Cu in. (cc)	Fuel Delivery	Horsepower @ rpm (gross)	Torque @ rpm (ft. lbs.) (gross)	Bore x Stroke (in.)	Compression Ratio	Oil Pressure @ rpm (psi)
1970	B 20 B	122 (1990)	2 sidedraft Zenith-Stromberg 175 CD 2SE	118 @ 5800	123 @ 3500	3.500 x 3.150	9.3:1	36–85 @ 2000
1971–72	B 20 B	122 (1990)	2 sidedraft SU HIF 6	118 @ 5800	123 @ 3500	3.5004 x 3.150	9.3:1	36–85 @ 2000
1970–71	B 20 E	122 (1990)	Bosch electronic fuel injection	130 @ 6000	130 @ 3500	3.5008 x 3.150	10.5:1	36–85 @ 2000
1972	B 20 F	122 (1990)	Bosch electronic fuel injection	125 @ 3500	123 @ 3500	3.5008 x 3.150	8.7:1	36–85 @ 2000
1970–72	B 30 A	183 (2978)	2 sidedraft Zenith-Stormberg 175 CD 2SE	145 @ 5500	163 @ 3000	3.5000 x 3.150	9.3:1	36–85 @ 2000
1972	B 30 F	183 (2978)	Bosch electronic fuel injection	160 @ 5800	167 @ 2500	3.5010 x 3.150	8.7:1	36–85 @ 2000
1973–74	B 30 F	183 (2978)	Bosch electronic fuel injection	138 @ 5500	155 @ 3500	3.501 x 3.150	8.7:1	36–85 @ 2000
1975	B 30 F	183 (2978)	Bosch electronic fuel injection	130 @ 5250 ③	150 @ 4000 ④	3.501 x 3.150	8.7:1	36–85 @ 2000
1976–78	B 27 F	162 (2660)	Bosch continuous injection	125 @ 5500 ⑦	150 @ 2750 ⑧	3.4646 x 2.8740	8.2:1	58 @ 3000
1973	B 20 F	122 (1990)	Bosch electronic fuel injection	112 @ 6000	115 @ 3500	3.5008 x 3.150	8.7:1	36–85 @ 2000
1974	B 20 F	122 (1990)	Bosch continuous injection	109 @ 6000	115 @ 3500	3.5008 x 3.150	8.7:1	36–85 @ 2000
1975	B 20 F	122 (1990)	Bosch continuous injection	98 @ 6000 ①	110 @ 3500 ②	3.5008 x 3.150	8.7:1	36–85 @ 2000
1976–78	B 21 F	130 (2127)	Bosch continuous injection	102 @ 5200 ⑤	114 @ 2500 ⑥	3.623 x 3.150	8.5:1	35–85 @ 2000
1979–82	B 21 F	130 (2127)	Bosch continuous fuel injection	107 @ 5250	117 @ 2500 ⑨	3.623 x 3.150	9.3:1	35–85 @ 2000

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General Engine Specifications (cont.)

Year	Model	Engine Displacement cu. in. (cc)	Fuel System Type	Net Horsepower @ rpm	Net Torque @ rpm (ft. lbs.)	Bore x Stroke (in.)	Com-pression Ratio	Oil Pressure @ rpm
1982	240 DL	130 (2127) B21F	CIS	98 @ 5000	112 @ 3000	3.62 x 3.15	9.3:1	35–85 @ 2000
	DL ⑫	130 (2127) B21F	LH	105 @ 5400	119 @ 3000	3.62 x 3.15	9.3:1	35–85 @ 2000
	DL ⑩	130 (2127) B21A	1-bbl Zenith	100 @ 5250	122 @ 2500	3.62 x 3.15	9.3:1	35–85 @ 2000
	GL	130 (2127) B21F	CIS	98 @ 5000	112 @ 3000	3.62 x 3.15	9.3:1	35–85 @ 2000
	GL	145 (2383) D24	DFI	76 @ 4800	98 @ 2800	3.01 x 3.40	23.0:1	28 @ 2000
	GL ⑩	140 (2320) B23E	CIS	127 @ 5500	133 @ 4500	3.78 x 3.15	10.0:1	35–85 @ 2000
	GLT	130 (2127) B21F-Turbo	CIS	127 @ 5400	150 @ 3750	3.62 x 3.15	7.5:1	35–85 @ 2000
	GLT	130 (2127) B21F	CIS	98 @ 5000	112 @ 3000	3.62 x 3.15	9.3:1	35–85 @ 2000
	GLT ⑩	140 (2320) B23E	CIS	127 @ 5500	133 @ 4500	3.78 x 3.15	10.0:1	35–85 @ 2000
	260 GLE	174 (2849) B28F	CIS	130 @ 5500	153 @ 2750	3.58 x 2.86	8.8:1	60 @ 3000
1983	240 DL	140 (2320) B23F	LH	107 @ 5400	127 @ 3500	3.78 x 3.15	10.3:1	35–85 @ 2000
	DL	130 (2127) B21F-Turbo	CIS	127 @ 5400	150 @ 3750	3.62 x 3.15	7.5:1	35–85 @ 2000
	DL	145 (2383) D24	DFI	78 @ 4800	102 @ 3000	3.01 x 3.40	23.5:1	28 @ 2000
	DL ⑩	130 (2127) B21A	1-bbl Zenith	100 @ 5250	122 @ 2500	3.62 x 3.15	9.3:1	35–85 @ 2000
	GL	140 (2320) B23F	LH	107 @ 5400	127 @ 3500	3.78 x 3.15	10.3:1	35–85 @ 2000
	GL	145 (2383) D24	DFI	78 @ 4800	102 @ 3000	3.01 x 3.40	23.5:1	28 @ 2000
	GL ⑩	140 (2320) B23E	CIS	115 @ 5000	133 @ 3000	3.62 x 3.15	10.3:1	35–85 @ 2000
	GLT ⑩	140 (2320) B23E	CIS	115 @ 5000	133 @ 3000	3.62 x 3.15	10.3:1	35–85 @ 2000
	Turbo	130 (2127) B21F-Turbo	CIS	127 @ 5400	150 @ 3750	3.62 x 3.15	7.5:1	35–85 @ 2000
	760 GLE	174 (2849) B28F	CIS	134 @ 5500	159 @ 2700	3.58 x 2.86	8.8:1	60 @ 3000
	GLE	145 (2383) D24-Turbo	DFI	106 @ 4800	140 @ 2400	3.01 x 3.40	23.0:1	28 @ 2000
	Turbo	140 (2320) B23F-Turbo	LH	157 @ 5300	184 @ 2900	3.78 x 3.15	8.7:1	35–85 @ 2000
1984	240 Diesel	145 (2383) D24	DFI	78 @ 4800	102 @ 3000	3.01 x 3.40	23.5:1	28 @ 2000
	DL	140 (2320) B23F ⑬	LH	113 @ 5400	136 @ 2750	3.78 x 3.15	9.5:1	35–85 @ 2000

87863C12

General Engine Specifications (cont.)

Year	Model	Engine Displacement cu. in. (cc)	Fuel System Type	Net Horsepower @ rpm	Net Torque @ rpm (ft. lbs.)	Bore x Stroke (in.)	Com-pression Ratio	Oil Pressure @ rpm
1984	DL	140 (2320) B23F ⑭	LH	114 @ 5400	133 @ 3500	3.78 x 3.15	10.3:1	35–85 @ 2000
	DL ⑩	130 (2127) B21A	1-bbl Zenith	100 @ 5250	122 @ 2500	3.62 x 3.15	9.3:1	35–85 @ 2000
	GL	140 (2320) B23F ⑬	LH	113 @ 5400	136 @ 2750	3.78 x 3.15	9.5:1	35–85 @ 2000
	GL	140 (2320) B23F ⑭	LH	114 @ 5400	133 @ 3500	3.78 x 3.15	10.3:1	35–85 @ 2000
	GLE ⑩	140 (2320) B23F ⑬	LH	113 @ 5400	136 @ 2750	3.78 x 3.15	9.5:1	35–85 @ 2000
	GLE ⑩	140 (2320) B23F ⑭	LH	114 @ 5400	133 @ 3500	3.78 x 3.15	10.3:1	35–85 @ 2000
	Turbo	130 (2127) B21F-Turbo	CIS	131 @ 5400	155 @ 3750	3.62 x 3.15	7.5:1	35–85 @ 2000
	760 GLE	174 (2849) B28F	CIS	134 @ 5500	159 @ 2700	3.58 x 2.86	8.8:1	60 @ 3000
	GLE	145 (2383) D24-Turbo	DFI	106 @ 4800	140 @ 2400	3.01 x 3.40	23.0:1	28 @ 2000
	Turbo	140 (2320) B23F-Turbo	LH	157 @ 5300	184 @ 2900	3.78 x 3.15	8.7:1	35–85 @ 2000
1985	240 Diesel	145 (2383) D24	DFI	80 @ 4800	103 @ 2800	3.01 x 3.40	23.0:1	28 @ 2000
	DL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	GL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	Turbo	130 (2127) B21F-Turbo	CIS	162 @ 5100	181 @ 3900	3.62 x 3.15	7.5:1	35–85 @ 2000
	740 GLE	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	TD	145 (2383) D24-Turbo	DFI	106 @ 4800	140 @ 2400	3.01 x 3.40	23.0:1	28 @ 2000
	Turbo	140 (2320) B230F-Turbo	LH	160 @ 5300	187 @ 2900	3.78 x 3.15	8.7:1	35–85 @ 2000
	760 GLE	174 (2849) B28F	CIS	134 @ 5500	159 @ 2700	3.58 x 2.86	8.8:1	60 @ 3000
	GLE TD	145 (2383) D24-Turbo	DFI	106 @ 4800	140 @ 2400	3.01 x 3.40	23.0:1	28 @ 2000
	Turbo	140 (2320) B230F-Turbo	LH	160 @ 5300	187 @ 2900	3.78 x 3.15	8.7:1	35–85 @ 2000
1986	240 DL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	GL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	740 GL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	GLE	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000

87863C18

General Engine Specifications (cont.)

Year	Model	Engine Displacement cu. in. (cc)	Fuel System Type	Net Horsepower @ rpm	Net Torque @ rpm (ft. lbs.)	Bore x Stroke (in.)	Com-pression Ratio	Oil Pressure @ rpm
1986	GLE TD	145 (2383) D24-Turbo	DFI	106 @ 4800	140 @ 2400	3.01 x 3.40	23.0:1	28 @ 2000
	Turbo	140 (2320) B230F-Turbo	LH	160 @ 5300	187 @ 2900	3.78 x 3.15	8.7:1	35–85 @ 2000
	760 GLE	174 (2849) B28F	CIS	136 @ 5500	159 @ 2700	3.58 x 2.86	8.8:1	60 @ 3000
	Turbo	140 (2320) B230F-Turbo	LH	160 @ 5300	187 @ 2900	3.78 x 3.15	8.7:1	35–85 @ 2000
1987	240 DL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	GL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	740 GL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	GLE	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	Turbo	140 (2320) B230F-Turbo	LH	160 @ 5300	187 @ 2900	3.78 x 3.15	8.7:1	35–85 @ 2000
	760 GLE	174 (2849) B280F	LH	146 @ 5100	173 @ 3750	3.58 x 2.86	9.5:1	57 @ 3000
	Turbo	140 (2320) B230F-Turbo	LH	160 @ 5300	187 @ 2900	3.78 x 3.15	8.7:1	35–85 @ 2000
	780	174 (2849) B280F	LH	146 @ 5100	173 @ 3750	3.58 x 2.86	9.5:1	57 @ 3000
1988–89	240 DL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	GL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	740 GL	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	GLE	140 (2320) B230F	LH	114 @ 5400	136 @ 2750	3.78 x 3.15	9.8:1	35–85 @ 2000
	740 GLE 16v.	140 (2320) B234F	LH	153 @ 5700	150 @ 4450	3.78 x 3.15	10.0:1	35–85 @ 2000
	Turbo	140 (2320) B230F-Turbo	LH	160 @ 5300	187 @ 2900	3.78 x 3.15	8.7:1	35–85 @ 200
	760 GLE	174 (2849) B280F	LH	146 @ 5100	173 @ 3750	3.58 x 2.86	9.5:1	57 @ 3000
	Turbo	140 (2320) B230F-Turbo	LH	160 @ 5300	187 @ 2900	3.78 x 3.15	8.7:1	35–85 @ 2000
	780	174 (2849) B280F	LH	146 @ 5100	173 @ 3750	3.58 x 2.86	9.5:1	57 @ 3000

CIS—Continuous Injection System
DFI—Diesel Fuel Injection
LH—LH-Jetronic Injection
① 94 @ 6000 w/catalytic converter
② 105 @ 3500 w/catalytic converter
③ 125 @ 5250 w/catalytic converter
④ 145 @ 4000 w/catalytic converter
⑤ 99 @ 5200 in Calif.
⑥ 114 @ 2500 in Calif.
⑦ 121 @ 5500 in Calif.
⑧ 148 @ 2750 in Calif.
⑨ 114 in Calif.
⑩ Canada only
⑪ Station Wagon
⑫ California only
⑬ With manual transmission
⑭ With automatic transmission

87863C19

Valve Specifications

Year	Engine and displacement Cu. In. (cc)	Seat Angle (deg)	Face Angle (deg)	Spring Test Pressure (lbs. @ in.)	Spring Installed Height (in.)	Stem to Guide Clearance (in.)		Stem Diameter (in.)	
						Intake	Exhaust	Intake	Exhaust
1970–72	B 20 B 109 (1780)	44.5	45	181.5 @ 1.18	1.81	0.0010–0.0022	0.0026–0.0037	0.3419–0.3425	0.3403–0.3409
1970–71 1972–75	B 20 E 122 (1990) B 20 F 122 (1990)	44.5	45	181.5 @ 1.18	1.81	0.0012–0.0026	0.0024–0.0038	0.3132–0.0138	0.3120–0.3126
1970–72	B 30 A 183 (2978)	44.5	45	145.0 @ 1.20	1.77	0.0012–0.0026	0.0024–0.0038	0.3132–0.3138	0.3120–0.3126
1972–75	B 30 F 183 (2978)	44.5	45	181.5 @ 1.18	1.81	0.0012–0.0026	0.0024–0.0038	0.3132–0.3138	0.3120–0.3126
1976–83	B 21 130 (2127)	44.75	45.5	170 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3135	0.3126–0.3128
1983	B 23 140 (2320)	45	44.5	165 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3138	0.3124–0.3128
1976–79	B 27 F 162 (2660)	29.5 Int 30 Exh	29.5 Int 20 Exh	124.3 @ 1.27	1.86	①	①	0.3136–0.3142 to 0.3140–0.3146	0.3128–0.3134 to 0.3136–0.3142
1980–83	B 28 F 173 (2849)	29.5 Int 30 Exh	29.5 Int 30 Exh	143 @ 1.181	1.854	①	①	0.3136–0.3142 to 0.3140–0.3146	0.3128–0.3134 to 0.3136–0.3142
1980–81	D 24, D 24 T Diesel	45	②	③	④	⑤	⑤	0.314	0.313
1982	130 (2127) B21F	44.75	45.5	170 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3135	0.3128–0.3126
	130 (2127) B21A ⑥	44.75	45.5	170 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3135	0.3128–0.3126
	130 (2127) B21F-Turbo	44.75	45.5	170 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3135	0.3128–0.3126
	140 (2320) B23E ⑥	45	44.5	165 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3138	0.3128–0.3124
	145 (2383) D24	45	②	③	④	⑤	⑤	0.3140	0.3130
	174 (2849) B28F	⑦	⑦	143 @ 1.18	1.85	①	①	⑧	⑧
1983	130 (2127) B21A ⑥	44.75	45.5	170 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3135	0.3128–0.3126
	130 (2127) B21F-Turbo	44.75	45.5	170 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3135	0.3128–0.3126
	140 (2320) B23F	45	44.5	165 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3138	0.3128–0.3124
	140 (2320) B23E ⑥	45	44.5	165 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3138	0.3128–0.3124
	140 (2320) B23F-Turbo	45	44.5	165 @ 1.06	1.77	0.0012–0.0024	0.0024–0.0035	0.3132–0.3138	0.3128–0.3124
	145 (2383) D24	45	②	③	④	⑤	⑤	0.3140	0.3130
	145 (2383) D24-Turbo	45	②	③	④	⑥	⑤	0.3140	0.3130
	174 (2849) B28F	⑦	⑦	143 @ 1.18	1.85	①	①	⑧	⑧

87863C20

Valve Specifications (cont.)

Year	Engine Displacement cu. in. (cc)	Seat Angle (deg.)	Face Angle (deg.)	Spring Test Pressure (lbs. @ in.)	Spring Installed Height (in.)	Stem-to-Guide Clearance (in.)		Stem Diameter (in.)	
						Intake	Exhaust	Intake	Exhaust
1984	130 (2127) B21A ⑥	44.75	45.5	170 @ 1.06	1.77	0.0012– 0.0024	0.0024– 0.0035	0.3132– 0.3135	0.3128– 0.3126
	130 (2127) *B21F-Turbo*	*44.75*	*45.5*	*170 @ 1.06*	*1.77*	*0.0012–* *0.0024*	*0.0024–* *0.0035*	*0.3132–* *0.3135*	*0.3128–* *0.3126*
	140 (2320) B23F	45	44.5	165 @ 1.06	1.77	0.0012– 0.0024	0.0024– 0.0035	0.3132– 0.3138	0.3128– 0.3124
	140 (2320) B23F-Turbo	45	44.5	165 @ 1.06	1.77	0.0012– 0.0024	0.0024– 0.0035	0.3132– 0.3138	0.3128– 0.3124
	145 (2383) D24	45	②	③	④	⑤	⑤	0.3140	0.3130
	145 (2383) D24-Turbo	45	②	③	④	⑤	⑤	0.3140	0.3130
	174 (2849) B28F	⑦	⑦	143 @ 1.18	1.85	①	①	②	②
1985	130 (2127) B21F-Turbo	44.75	45.5	170 @ 1.06	1.77	0.0012– 0.0024	0.0024– 0.0035	0.3132– 0.3135	0.3128– 0.3126
	140 (2320) B230F	45	44.5	170 @ 1.06	1.79	0.0012– 0.0024	0.0024– 0.0036	0.3132– 0.3138	0.3128– 0.3134
	140 (2320) B230F-Turbo	45	44.5	170 @ 1.06	1.79	0.0012– 0.0024	0.0024– 0.0036	0.3132– 0.3138	0.3128– 0.3134
	145 (2383) D24	45	②	③	④	⑤	⑤	0.3140	0.3130
	145 (2383) D24-Turbo	45	②	③	④	⑤	⑤	0.3140	0.3130
	174 (2849) B28F	⑦	⑦	143 @ 1.18	1.85	①	①	⑧	⑧
1986	140 (2320) B230F	45	44.5	158 @ 1.08	1.79	0.0012– 0.0024	0.0024– 0.0036	0.3132– 0.3138	0.3128– 0.3134
	140 (2320) B230F-Turbo	45	44.5	158 @ 1.08	1.79	0.0012– 0.0024	0.0024– 0.0036	0.3132– 0.3138	0.3128– 0.3134
	145 (2383) D24-Turbo	45	②	③	④	⑤	⑤	0.3140	0.3130
	174 (2849) B28F	⑦	⑦	143 @ 1.18	1.85	①	①	⑧	⑧
1987	140 (2320) B230F	45	44.5	158 @ 1.08	1.79	0.0012– 0.0024	0.0024– 0.0036	0.3132– 0.3138	0.3128– 0.3134
	140 (2320) B230F-Turbo	45	44.5	158 @ 1.08	1.79	0.0012– 0.0024	0.0024– 0.0036	0.3132– 0.3138	0.3128– 0.3134
	174 (2849) B280F	45	44.5	143 @ 1.18	1.85	①	①	⑧	⑧
1988–89	140 (2320) B230F	45	44.5	158 @ 1.08	1.79	0.0012– 0.0024	0.0024– 0.0036	0.3132– 0.3138	0.3128– 0.3134
	140 (2320) B230F-Turbo	45	44.5	158 @ 1.08	1.79	0.0012– 0.0024	0.0024– 0.0036	0.3132– 0.3138	0.3128– 0.3134
	174 (2849) B280F	45	44.5	143 @ 1.18	1.85	①	①	⑧	⑧
	140 (2320) B234F	45	44.5	144 @ 1.04	1.46	0.0012– 0.0024	0.0016– 0.0028	0.3132– 0.3138	0.3128– 0.3134

NOTE: Exhaust valves for turbo engines (including turbo diesel) are stellite coated and must not be machined. They may be ground against the valve seat.

① Tapered; valve guide ID is 0.3150–0.3158

② 44.5° intake; 45° exhaust

③ Two springs per valve; inner spring 49 lbs. @ 0.72 in.; outer spring 100 lbs. @ 0.878 in.

④ Inner 1.335 in.; outer 1.583 in.

⑤ Clearance measured with new valve guide and with valve stem edge to edge with valve guide upper end. Max. clearance 0.051 in.; new clearance 0.012 in

⑥ Canada only

⑦ Intake: 29.5 degrees
Exhaust: 30 degrees

⑧ Tapered valve stem;
Intake: Base = 0.3135–0.3141 Top = 3139–0.3145
Exhaust: Base = 0.3127–0.3133 Top = 3136–0.3141

Crankshaft and Connecting Rod Specifications

All measurements are given in inches

Year	Engine Displacement Cu. in. (cc)	Crankshaft				Connecting Rod		
		Main Brg Journal Dia	Main Brg Oil Clearance	Shaft End-Play	Thrust on No.	Journal Diameter	Oil Clearance	Side Clearance
1970–71	B 20 122 (1990)	2.4981– 2.4986	0.0011– 0.0031	0.0018– 0.0054	5	2.1299– 2.1304	0.0012– 0.0028	0.006– 0.014
1972–73	B 20 122 (1990)	2.4981– 2.4986	0.0011– 0.0033	0.0018– 0.0054	5	2.1299– 2.1304	0.0012– 0.0028	0.006– 0.014
1974–75	B 20 122 (1990)	2.4981– 2.4986	0.0011– 0.0033	0.0018– 0.0054	5	2.1255– 2.1260	0.0012– 0.0028	0.006– 0.014
1970–71	B 30 183 (2978)	2.4981– 2.4986	0.0011– 0.0031	0.0018– 0.0054	7	2.1299– 2.1304	0.0012– 0.0028	0.006– 0.014
1972–73	B 30 183 (2978)	2.4981– 2.4986	0.0011– 0.0033	0.0018– 0.0054	7	2.1299– 2.1304	0.0012– 0.0028	0.006– 0.014
1974–75	B 30 183 (2978)	2.4981– 2.4986	0.0011– 0.0033	0.0018– 0.0054	7	2.1255– 2.1260	0.0012– 0.0028	0.006– 0.014
1976–83	B 21 130 (2127)	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
1983	B 23 140 (2320)	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
1976–83	B 27 162 (2660) B 28 173 (2849)	2.7576– 2.7583	0.0015– 0.0035	0.0028– 0.0106	4	2.0578– 2.0585	0.0012– 0.0031	0.008– 0.015
1980–83	D 24 145 (2383) Diesel	2.2833– 2.2825	0.0006– 0.0029	0.0028– 0.0071	4	1.8802– 1.8810	0.0047 ①	0.0158
1983	D 24 T 145 (2383) Turbo Diesel	2.2816– 2.2824	0.0006– 0.0029	0.0027– 0.0071		1.8802– 1.8810	0.0047 ①	0.0157
1984	130 (2127) B21A ②	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	130 (2127) B23F	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	140 (2320) B23F-Turbo	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	140 (2320) B23F-Turbo	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	145 (2383) D24	2.2833– 2.2825	0.0006– 0.0030	0.0028– 0.0071	4	1.8802– 1.8810	0.0047 ①	0.0158
	145 (2383) D24-Turbo	2.2833– 2.2825	0.0006– 0.0030	0.0028– 0.0071	4	1.8802– 1.8810	0.0047 ①	0.0158
	174 (2849) B28F	2.7583	0.0035	0.0106	4	2.0585	0.0031	0.015
1985	130 (2127) B21F-Turbo	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	140 (2320) B230F	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	140 (2320) B230F-Turbo	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	145 (2383) D24	2.2833– 2.2825	0.0006– 0.0030	0.0028– 0.0071	4	1.8802– 1.8810	0.0047 ①	0.0158
	145 (2383) D24-Turbo	2.2833– 2.2825	0.0006– 0.0030	0.0028– 0.0071	4	1.8802– 1.8810	0.0047 ①	0.0158
	174 (2849) B28F	2.7583	0.0035	0.0106	4	2.0585	0.0031	0.015

87863C24

Crankshaft and Connecting Rod Specifications

All measurements are given in inches

Year	Engine Displacement Cu. In. (cc)	Crankshaft				Connecting Rod		
		Main Brg Journal Dia	Main Brg Oil Clearance	Shaft End-Play	Thrust on No.	Journal Diameter	Oil Clearance	Side Clearance
1986	140 (2320) B230F	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	140 (2320) B230F-Turbo	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	145 (2383) D24-Turbo	2.2833– 2.2825	0.0006– 0.0030	0.0028– 0.0071	4	1.8802– 1.8810	0.0047 ①	0.0158
	174 (2849) B28F	2.7583	0.0035	0.0106	4	2.0585	0.0031	0.015
1987–88	140 (2320) B230F	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	140 (2320) B230F-Turbo	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.1255– 2.1260	0.0009– 0.0028	0.006– 0.014
	174 (2849) B280F	2.7583	0.0035	0.0106	4	2.0585	0.0031	0.015
	140 (2320) B234F	2.4981– 2.4986	0.0011– 0.0033	0.0015– 0.0058	5	2.047	0.0009– 0.0028	0.006– 0.018

① New clearance: 0.0005–0.0024 in.
② Canada only

87903C27

Piston and Ring Specifications

All measurements in inches

Year	Engine Displacement Cu. In. (cc)	Piston Clearance	Ring Gap			Ring Side Clearance		
			Top Compression	Bottom Compression	Oil Control	Top Compression	Bottom Compression	Oil Control
1970	B 20 B 122 (1990)	0.0008–0.0016	0.016–0.022	0.016–0.022	0.016–0.022	0.0017–0.0028	0.0017–0.0028	0.0017–0.0028
	B 30 A 183 (2978)	0.0008–0.0016	0.016–0.022	0.016–0.022	0.016–0.022	0.0017–0.0028	0.0017–0.0028	0.0017–0.0028
1971	B 20 B 122 (1990)	0.0014–0.0022	0.016–0.022	0.016–0.022	0.016–0.022	0.0017–0.0028	0.0017–0.0028	0.0017–0.0028
1971	B 20 E 122 (1990)	0.0016–0.0024	0.016–0.022	0.016–0.022	0.016–0.022	0.0017–0.0028	0.0017–0.0028	0.0017–0.0028
	B 30 A 183 (2978)	0.0016–0.0024	0.016–0.022	0.016–0.022	0.016–0.022	0.0017–0.0028	0.0017–0.0028	0.0017–0.0028
1972	B 20 B 122 (1990)	0.0014–0.0020	0.016–0.022	0.016–0.022	0.016–0.022	0.0016–0.0028	0.0016–0.0028	0.0016–0.0028
1972–75	B 20 F 122 (1990)	0.0016–0.0024 ①	0.016–0.022	0.016–0.022	0.016–0.022	0.0016–0.0028	0.0016–0.0028	0.0016–0.0028
1972	B 30 A 183 (2978)	0.0016–0.0024	0.016–0.022	0.016–0.022	0.016–0.022	0.0016–0.0028	0.0016–0.0228	0.0016–0.0028
1972–75	B 30 F 183 (2978)	0.0016–0.0024 ①	0.016–0.022	0.016–0.022	0.016–0.022	0.0016–0.0032	0.0016–0.0028	0.0016–0.0028
1976–83	B 21 130 (2127)	0.0004–0.0012 ③⑥	0.0138–0.0217 ④	0.0138–0.0217 ④	0.010–0.016 ④	0.0016–0.0028	0.0016–0.0028	0.0016–0.0028 ⑤
1983	B 23 140 (2320)	0.0020–0.0028 ⑦	0.014–0.026	0.014–0.022	0.010–0.024	0.0015–0.0028	0.0015–0.0028	0.0012–0.0024
1976–83	B 27 F 162 (2660), B 28 F 173 (2849)	0.0008–0.0016 ②	0.016–0.022	0.016–0.022	0.015–0.055	0.0018–0.0029	0.0010–0.0021	0.0004–0.0092
1980–83	D 24 Diesel 145 (2383)	0.0012–0.0020 ⑧	0.012–0.020 ⑨	0.012–0.020 ⑨	0.010–0.016 ⑨	0.0024–0.0035 ⑩	0.0020–0.0032 ⑩	0.0012–0.0024 ⑪
1983	D 24 T Diesel 145 (2383)	0.0012–0.0020	0.012–0.020	0.012–0.020	0.010–0.019	0.0043–0.0055	0.0028–0.0039	0.0012–0.0028
	130 (2127) B21A ⑫	0.0004–0.0016	0.0140–0.0260	0.0140–0.0220	0.010–0.024	0.0016–0.0026	0.0016–0.0028	0.0012–0.0024
	130 (2127) B21F-Turbo	0.0008–0.0016	0.0140–0.0260	0.0140–0.0220	0.010–0.024	0.0016–0.0028	0.0016–0.0028	0.0012–0.0024
	140 (2320) B23E ⑫	0.0020–0.0028 ⑬	0.0014–0.0026	0.0014–0.0022	0.010–0.024	0.0015–0.0028	0.0015–0.0028	0.0012–0.0024
	140 (2320) B23F	0.0020–0.0028 ⑬	0.0014–0.0026	0.0014–0.0022	0.010–0.024	0.0015–0.0028	0.0015–0.0028	0.0012–0.0024
	140 (2320) B23F-Turbo	0.0020–0.0028 [illegible]	0.0014–0.0026	0.0014–0.0022	0.010–0.024	0.0015–0.0028	0.0015–0.0028	0.0012–0.0024
	145 (2383) D24	0.0012–0.0020	0.0012–0.0020	0.0012–0.0020	0.010–0.019	0.0043–0.0055	0.0028–0.0039	0.0012–0.0028
	145 (2383) D24-Turbo	0.0012–0.0020	0.0012–0.0020	0.0012–0.0020	0.010–0.019	0.0043–0.0055	0.0028–0.0039	0.0012–0.0028
	174 (2849) B28F	0.0007–0.0015	0.0157–0.0236	0.0157–0.0236	0.0157–0.0570	0.0017–0.0029	0.0009–0.0212	0.0003–0.0091

Piston and Ring Specifications

All measurements in inches

Year	Engine Displacement cu. in. (cc)	Piston Clearance	Ring Gap			Ring Side Clearance		
			Top Compression	Bottom Compression	Oil Control	Top Compression	Bottom Compression	Oil Control
1984	130 (2127) B21A ⑫	0.0004– 0.0016	0.0140– 0.0260	0.0140– 0.0220	0.010– 0.024	0.0016– 0.0028	0.0016– 0.0028	0.0012– 0.0024
	130 (2127) B21F-Turbo	0.0008– 0.0016	0.0140– 0.0260	0.0140– 0.0220	0.010– 0.024	0.0016– 0.0028	0.0016– 0.0028	0.0012– 0.0024
	140 (2320) B23F	0.0020– 0.0028 ⑬	0.0014– 0.0026	0.0014– 0.0022	0.010– 0.024	0.0015– 0.0028	0.0015– 0.0028	0.0012– 0.0024
	140 (2320) B23F-Turbo	0.0020– 0.0028 ⑬	0.0014– 0.0026	0.0014– 0.0022	0.010– 0.024	0.0015– 0.0028	0.0015– 0.0028	0.0012– 0.0024
	145 (2383) D24	0.0012– 0.0020	0.0012– 0.0020	0.0012– 0.0020	0.010– 0.019	0.0043– 0.0055	0.0028– 0.0039	0.0012– 0.0028
	145 (2383) D24-Turbo	0.0012– 0.0020	0.0012– 0.0020	0.0012– 0.0020	0.010– 0.019	0.0043– 0.0055	0.0028– 0.0039	0.0012– 0.0028
	174 (2849) B28F	0.0007– 0.0015	0.0157– 0.0236	0.0157– 0.0236	0.0157– 0.0570	0.0017– 0.0029	0.0009– 0.0212	0.0003– 0.0091
1985	130 (2127) B21F-Turbo	0.0008– 0.0016	0.0140– 0.0260	0.0140– 0.0220	0.010– 0.024	0.0016– 0.0028	0.0016– 0.0028	0.0012– 0.0024
	140 (2320) B230F	0.0004– 0.0012	0.0118– 0.0217	0.0118– 0.0217	0.0118– 0.0236	0.0024– 0.0036	0.0016– 0.0028	0.0012– 0.0026
	140 (2320) B230F-Turbo	0.0004– 0.0012	0.0118– 0.0217	0.0118– 0.0217	0.0118– 0.0236	0.0024– 0.0036	0.0016– 0.0028	0.0012– 0.0026
	145 (2383) D24	0.0012– 0.0020	0.0012– 0.0020	0.0012– 0.0020	0.010– 0.019	0.0043– 0.0055	0.0028– 0.0039	0.0012– 0.0028
	145 (2383) D24-Turbo	0.0012– 0.0020	0.0012– 0.0020	0.0012– 0.0020	0.010– 0.019	0.0043– 0.0055	0.0028– 0.0039	0.0012– 0.0028
	174 (2849) B28F	0.0007– 0.0015	0.0157– 0.0236	0.0157– 0.0236	0.0157– 0.0570	0.0017– 0.0029	0.0009– 0.0212	0.0003– 0.0091
1986	140 (2320) B230F	0.0004– 0.0012	0.0118– 0.0217	0.0118– 0.0217	0.0118– 0.0236	0.0024– 0.0036	0.0016– 0.0028	0.0012– 0.0026
	140 (2320) B230F-Turbo	0.0004– 0.0012	0.0118– 0.0217	0.0118– 0.0217	0.0118– 0.0236	0.0024– 0.0036	0.0016– 0.0028	0.0012– 0.0026
	145 (2383) D24-Turbo	0.0012– 0.0020	0.0012– 0.0020	0.0012– 0.0020	0.010– 0.019	0.0043– 0.0055	0.0028– 0.0039	0.0012– 0.0028
	174 (2849) B28F	0.0007– 0.0015	0.0157– 0.0236	0.0157– 0.0236	0.0157– 0.0570	0.0017– 0.0029	0.0009– 0.0212	0.0003– 0.0091
1987	140 (2320) B230F	0.0004– 0.0012	0.0118– 0.0217	0.0118– 0.0217	0.0118– 0.0236	0.0024– 0.0036	0.0016– 0.0028	0.0012– 0.0026
	140 (2320) B230F-Turbo	0.0004– 0.0012	0.0118– 0.0217	0.0118– 0.0217	0.0118– 0.0236	0.0024– 0.0036	0.0016– 0.0028	0.0012– 0.0026
1987	174 (2849) B280F	0.0007– 0.0015	0.0157– 0.0236	0.0157– 0.0236	0.0157– 0.0570	0.0017– 0.0029	0.0009– 0.0212	0.0003– 0.0091
1988–89	140 (2320) B230F	0.0004– 0.0012	0.0118– 0.0217	0.0118– 0.0217	0.0118– 0.0236	0.0024– 0.0036	0.0016– 0.0028	0.0012– 0.0026
	140 (2320) B230F-Turbo	0.0004– 0.0012	0.0018– 0.0217	0.0118– 0.0217	0.0118– 0.0236	0.0024– 0.0036	0.0016– 0.0028	0.0012– 0.0026
	174 (2849) B280F	0.0007– 0.0015	0.0157– 0.0236	0.0157– 0.0236	0.0157– 0.0570	0.0017– 0.0029	0.0009– 0.0212	0.0003– 0.0091
	140 (2320) B234F	0.0004– 0.0012	0.012– 0.022	0.012– 0.022	0.012– 0.024	0.0024– 0.0036	0.0016– 0.0028	0.0012– 0.0026

① 1974–75 piston clearance—0.0004–0.0012 in.
② Mahle pistons. Demolin pistons: 0.00315–0.00394 in.
③ 0.0004–0.0016 in. 1983
④ 1983 0.014–0.026 in. top compression; 0.014–0.022 in. bottom compression; 0.010–0.024 in. oil control
⑤ 0.0012–0.0024 in. 1983
⑥ 0.0008–0.0016 in. 1983 Turbo
⑦ Pistons with two different heights have been fitted to B23E engines. Piston clearance on version 1 (3.1654 in. piston height) is as shown above; clearance on version 2 pistons (3.0079 in. piston height) is 0.0004–0.0016 in.
⑧ Clearance when new; max. wear compared with normal diameter 0.0016 in.
⑨ Gap when new; maximum is 0.040 in.
⑩ Clearance when new; maximum 0.0079 in.
⑪ Clearance when new; maximum 0.0059 in.
⑫ Canada only
⑬ Pistons with two different heights have been fitted to B23E engines. Piston clearance on version 1 (3.1654 in piston height) listed above; clearance on version 2 pistons (3.0079 in.) is 0.004–0.0016 in.

Torque Specifications (cont.)

All readings in ft. lbs.

Year	Engine Displacement cu.in.(cc)	Cylinder Head Bolts	Main Bearing Bolts	Rod Bearing Bolts	Crankshaft Pulley Bolts	Flywheel-Bolts	Manifold Bolts		Spark Plugs
							Intake	Exhaust	
1970–73	All	65 ①	87–94	38–42	50–58	36–40	13–16	13–16	25–29
1974–75	All	65 ①	87–94	51–57	69–76 ②	47–51	13–16	13–16	25–29
1976–83	140 (2320) B 21 F	76–83 ③	85–91	43–48	107–128	47–54	15	15	25–29
1981–83	130 (2127) B 21 A, B 21 FT 140 (2320) B 23	⑫	85–91	43–48	107–128	47–54	15	15	15–18
1976–83	162 (2660) B 27 F, 173 (2849) B 28 F	④	⑤	33–37	118–132 ⑥	33–37	7–11	7–11	13–15
1980–83	145 (2383) D 24, D 24 T Diesel	65 ⑦⑪	48	33	330 ⑧	55	18	18	⑨
1984	130 (2127) B21A ⑬	⑫	85–91	43–48	107–128	47–54	15	15	15–18
	130 (2127) B21F-Turbo	⑫	85–91	43–48	107–128	47–54	15	15	15–18
	140 (2320) B21F	⑫	85–91	43–48	107–128	47–54	15	15	15–18
	140 (2320) B23F-Turbo	⑫	85–91	43–48	107–128	47–54	15	15	15–18
	145 (2383) D24	⑪	48	33	332 ⑧	55	18	18	⑨
	145 (2383) D24-Turbo	⑪	48	33	332 ⑧	55	18	18	⑨
	174 (2849) B28F	④ ⑪	⑤	33–37	177–206	33–37	7–11	7–11	8–11
1985	130 (2127) B21F-Turbo	⑫	85–91	43–48	107–128	47–54	15	15	15–18
	140 (2320) B230F	⑫	80	14 ⑭	43 ⑮	47–54	12	12	18
	140 (2320) B230F-Turbo	⑫	80	14 ⑭	43 ⑮	47–54	12	12	18
	145 (2383) D24	⑪	48	33	332 ⑧	55	18	18	⑨
	145 (2383) D24-Turbo	⑪	48	33	332 ⑧	55	18	18	⑨
	174 (2849) B28F	④	⑤	33–37	177–206	33–37	7–11	7–11	8–11

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Torque Specifications (cont.)

All readings in ft. lbs.

Year	Engine Displacement cu. in. (cc)	Cylinder Head Bolts	Main Bearing Bolts	Rod Bearing Bolts	Crankshaft Pulley Bolts	Flywheel Bolts	Manifold Bolts		Spark Plugs
							Intake	Exhaust	
1986 ④	140 (2320) B230F	⑫	80	14 ⑨	43 ⑮	47–54	12	12	18
	140 (2320) B230F-Turbo	⑫	80	14 ⑨	43 ⑮	47–54	12	12	18
	145 (2383) D24-Turbo	⑪	48	33	332 ⑧	55	18	18	⑨
	174 (2849) B28F	④	⑤	33–37	177–206	33–37	7–11	7–11	8–11
1987	140 (2320) B230F	⑫	80	14 ⑨	43 ⑮	47–54	12	12	18
	140 (2320) B230F-Turbo	⑫	80	14 ⑨	43 ⑮	47–54	12	12	18
	174 (2849) B280F	④	⑤	33–37	177–206	33–37	7–11	7–11	8–11
1988–89	140 (2320) B230F	⑫	80	14 ⑨	43 ⑮	47–54	12	12	18
	140 (2320) B230F-Turbo	⑫	80	14 ⑨	43 ⑮	47–54	12	12	18
	174 (2849) B280F	④	⑤	33–37	177–206	33–37	7–11	7–11	8–11
	140 (2320) B234	⑫	80	14 ⑨	43 ⑮	47–54	12	12	14–20

①Torque head bolts in three stages; first, torque in sequence to 29 ft. lbs., then to 58 ft. lbs., and finally after driving the car for 10 minutes, torque to the final figure of 65 ft. lbs.

②Double pulley—80–101 ft. lbs.

③Torque head bolts in two stages; first, tighten in sequence to 43 ft. lbs., then to 76–83 ft. lbs.

④Torque head bolts in sequence to 7 ft lbs., then 22 ft. lbs., then 44 ft. lbs. Wait 10–15 minutes and slacken the bolts ½ turn. Then torque to 11-14 ft. lbs. and then protractor torque to 116–120° (⅓ of a turn). Finally run to operating temperature, shut off and allow to cool for 30 min. Following the sequence, slacken, torque to 11–14 ft. lbs., and protractor torque to 113–117° each bolt.

⑤Torque main bearing nuts to 22 ft. lbs. in sequence. Then slacken 1st nut ½ turn, tighten to 22–26 ft. lbs., and protractor torque to 73–77°. Repeat for remaining nuts following the sequence.

⑥1978–83: 175–200

⑦Torque head bolts in two stages; first to 30 ft. lbs., then to 65 ft. lbs. After driving 1,000 miles, torque to 62 ft. lbs. (engine warm).

⑧Using regular torque wrench. If Volvo wrench 5188 is used with torque wrench, tighten to 255 ft. lbs.

⑨Fuel injector: 50 ft. lbs.

⑩Front camshaft bolt: 33 ft. lbs.

⑪Rear camshaft bolt: 73 ft. lbs.
From late 1980 new type cylinder head bolts are used on the diesels. They are longer and 1 mm wider. Torquing these bolts is a six-step procedure:
a. Torque to 30 ft. lbs.
b. Torque to 44 ft. lbs.
c. Torque to 55 ft. lbs.
d. Tighten 180°, in one movement, without stopping.
e. Run engine until oil temperature is minimum 50°C–120°F, Tighten 90°, in one movement.
f. After driving 600–1,000 miles, retorque bolts w/engine cold. Do not slacken first.

⑫Torque head bolts in three stages; first, tighten in sequence to 15 ft. lbs., then to 44 ft. lbs. Protractor torque 90°, in one movement, without stopping

① Canada only

⑨ Angle - tighten 90°

⑩ Angle - tighten 60°

⑪ Torque all head bolts in sequence to 44 ft. lbs. (60Nm), then loosen bolt #1 and retorque it to 15 ft. lbs. (20Nm), then tighten it to 106°; repeat for all bolts following number sequence. Loosen and tighten one bolt at a time. Run engine to operating temperature. Then let cool for 2 hours. Finally, tighten each bolt in sequence an additional 45°.

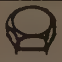
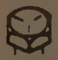
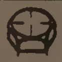
⑫ Torque all head bolts in sequence to 15 ft. lbs. Then repeat sequence tightening to 30 ft. lbs. Repeat sequence, protractor (angle) tightening through an *additional* 115° in one movement.

Standard Torque Specifications and Fastener Markings

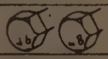
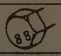
In the absence of specific torques, the following chart can be used as a guide to the maximum safe torque of a particular size/grade of fastener.

- There is no torque difference for fine or coarse threads.
- Torque values are based on clean, dry threads. Reduce the value by 10% if threads are oiled prior to assembly.
- The torque required for aluminum components or fasteners is considerably less.

U.S. Bolts

SAE Grade Number	1 or 2			5			6 or 7		
Number of lines always 2 less than the grade number.									
Bolt Size (Inches)—(Thread)	Maximum Torque			Maximum Torque			Maximum Torque		
	Ft./Lbs.	Kgm	Nm	Ft./Lbs.	Kgm	Nm	Ft./Lbs.	Kgm	Nm
¼—20	5	0.7	6.8	8	1.1	10.8	10	1.4	13.5
—28	6	0.8	8.1	10	1.4	13.6			
5/16—18	11	1.5	14.9	17	2.3	23.0	19	2.6	25.8
—24	13	1.8	17.6	19	2.6	25.7			
⅜—16	18	2.5	24.4	31	4.3	42.0	34	4.7	46.0
—24	20	2.75	27.1	35	4.8	47.5			
7/16—14	28	3.8	37.0	49	6.8	66.4	55	7.6	74.5
—20	30	4.2	40.7	55	7.6	74.5			
½—13	39	5.4	52.8	75	10.4	101.7	85	11.75	115.2
—20	41	5.7	55.6	85	11.7	115.2			
9/16—12	51	7.0	69.2	110	15.2	149.1	120	16.6	162.7
—18	55	7.6	74.5	120	16.6	162.7			
⅝—11	83	11.5	112.5	150	20.7	203.3	167	23.0	226.5
—18	95	13.1	128.8	170	23.5	230.5			
¾—10	105	14.5	142.3	270	37.3	366.0	280	38.7	379.6
—16	115	15.9	155.9	295	40.8	400.0			
⅞— 9	160	22.1	216.9	395	54.6	535.5	440	60.9	596.5
—14	175	24.2	237.2	435	60.1	589.7			
1— 8	236	32.5	318.6	590	81.6	799.9	660	91.3	894.8
—14	250	34.6	338.9	660	91.3	849.8			

Metric Bolts

Relative Strength Marking	4.6, 4.8			8.8		
Bolt Markings						
Bolt Size Thread Size x Pitch (mm)	Maximum Torque			Maximum Torque		
	Ft./Lbs.	Kgm	Nm	Ft./Lbs.	Kgm	Nm
6 x 1.0	2–3	.2–.4	3–4	3–6	.4–.8	5–8
8 x 1.25	6–8	.8–1	8–12	9–14	1.2–1.9	13–19
10 x 1.25	12–17	1.5–2.3	16–23	20–29	2.7–4.0	27–39
12 x 1.25	21–32	2.9–4.4	29–43	35–53	4.8–7.3	47–72
14 x 1.5	35–52	4.8–7.1	48–70	57–85	7.8–11.7	77–110
16 x 1.5	51–77	7.0–10.6	67–100	90–120	12.4–16.5	130–160
18 x 1.5	74–110	10.2–15.1	100–150	130–170	17.9–23.4	180–230
20 x 1.5	110–140	15.1–19.3	150–190	190–240	26.2–46.9	160–320
22 x 1.5	150–190	22.0–26.2	200–260	250–320	34.5–44.1	340–430
24 x 1.5	190–240	26.2–46.9	260–320	310–410	42.7–56.5	420–550

Engine

REMOVAL & INSTALLATION

➧ See Figure 33

B20 and B30 Engines

➧ See Figures 34 and 35

All Volvo engines and transmissions are removed as a unit. In most cases, a good chain hoist will suffice. Do not attempt to lift the engine with the chain wrapped around either the oil filter or the distributor. Lifting eyes may be fabricated from heavy gauge steel or angle iron.

1. Scribe the outline of the hinges on the hood and remove the hood.

✻✻CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Drain the oil from the crankcase. Open the drain plug on the right-hand side of the engine block, disconnect the lower radiator hose at the radiator, and drain the cooling system. On Volvos with automatic transmission, disconnect and plug the transmission cooler lines.

✻✻CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

Fig. 33 With the hood position outlined, use a socket to remove the hood bolts — an assistant will be needed

3. Remove the expansion tank, radiator cover plate, upper radiator hose, radiator, and fan shroud, if so equipped.
4. Remove the negative lead from the battery.
5. Remove and label the electric cables for the starter, the coil high tension wire, the distributor lead, alternator wires, water and oil temperature sensors, and the lead for the oil pressure sensor, if so equipped.
6. Remove and label the vacuum hoses for the distributor advance, and the power brake booster, if so equipped. Remove the positive crankcase ventilation (PCV) hoses, and the oil pressure gauge hose at the pipe connection, if so equipped.
    a. On electric fuel injected models, remove the air cleaner and intake hoses; pressure sensor hose from the inlet duct; the plug contacts for the temperature sensor, cold start valve, throttle valve switch, fuel injectors, and distributor impulse unit. Label all lines and hoses. In addition, remove the ground wire from the inlet duct, the throttle cable bracket from the inlet duct, the throttle cable from the throttle valve switch, the cold start valve fuel hose from the distribution pipe, the fuel return line from the pressure regulator, and the fuel inlet line from the distribution pipe. Remove the injectors by turning the lockrings counterclockwise and lifting them out of their bayonet fittings. The injectors should then be fitted with protective covers and plugs to prevent dirt from entering.
    b. On continuous (air-flow controlled) fuel injected models, disconnect the rubber hose to the control pressure regulator, the plastic hose from the pressure regulator to the fuel distributor, the hose at the cold start injector, the fuel filter hose, and the fuel return hose at the fuel distributor. Remove the pipe connecting the air cleaner and the intake manifold. Label all lines and hoses. Disconnect the electrical leads from the cold start injector, control pressure regulator, auxiliary air valve, coolant temperature sensor and the thermal time switch (engine side). Disconnect the ground wire for the control pressure regulator. Disconnect and plug the four fuel hoses at the injectors. Disconnect the throttle cable from the throttle and intake manifold. Disconnect the brake booster vacuum hose. Remove the thermal time switch.
    c. On carbureted models, remove the air cleaner, air intake hoses, and preheating plate. Also disconnect and plug the inlet hose to the fuel pump, disconnect the choke linkage, and remove the throttle control shaft from the pedal shaft, intermediate shaft, and bracket.
7. Disconnect the heater pipes from all models. Remove the exhaust pipe flange nuts and disconnect the exhaust pipe from the manifold. Remove the EGR valve pipe from the manifold. On models equipped with power steering, remove the steering pump bolts and place the pump and reservoir to one side.
8. On Volvos with manual transmission, place the gearshift in neutral and remove the shifter lever. On Volvos with automatic transmission, place the selector in PARK, disconnect the control rod from the selector lever, and the ground cable from the start inhibitor switch.
9. Disconnect the wires for the backup lights and overdrive, if so equipped. Remove the speedometer drive cable from the

transmission. Remove the clamp for the exhaust manifold and the clamp for the automatic transmission filler tube, if so equipped.

10. Jack up the vehicle and place two jackstands under the front jack attachments and two more in front of the rear jack attachments.

11. Place a hydraulic jack under the transmission (use a block of wood to protect the transmission from damage). On manual transmission cars, remove the return spring from the throw-out fork, and disconnect the clutch cable.

12. Separate the transmission (or overdrive) from the front universal joint by unbolting the flange. Unbolt the rear crossmember.

13. Disconnect the negative ground cable from the engine.

14. Remove the rear crossmember and rear engine mounts. Remove the lower nuts from the front engine mounts.

15. Install the lifting eyes and lifting crossbar. The lifting eyes are attached by ⅜ in. x 1¾ in. x 1 in. bolts. The engine is removed by raising its front and lowering its back while pulling forward until it clears the front crossmember, then leveling it and raising the complete unit. Lift out the engine and set it on an engine stand or rack.

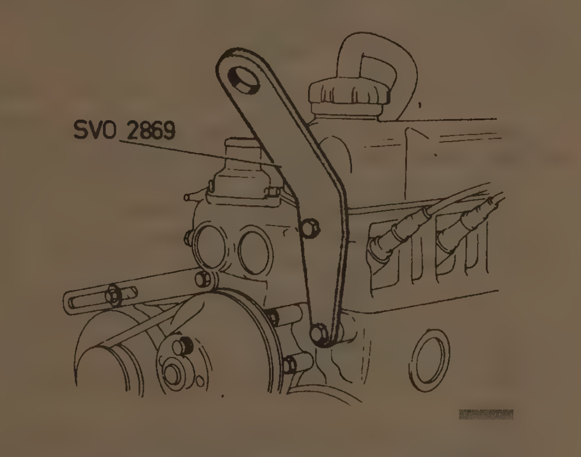


Fig. 34 Front lifting eye installed on a B20 engine — Volvo special tool shown

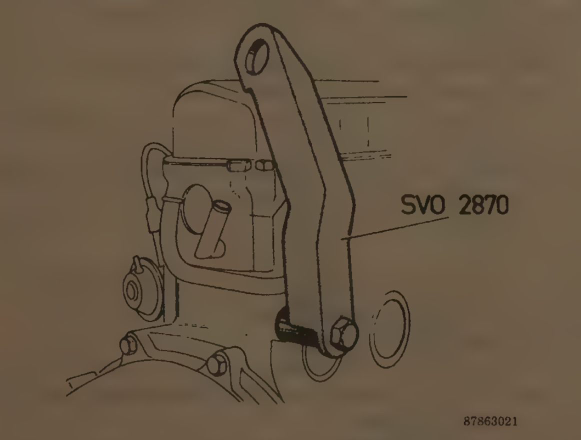


Fig. 35 Rear lifting eye installed on a B20 engine — Volvo special tool shown

To install:

16. Install the lifting apparatus on the engine. Make sure that the jackstands are located beneath the front jack attachments and in from of the rear jack attachments. Place the hydraulic jack beneath the transmission tunnel.

17. Carefully lower the engine into the engine compartment. Place the hydraulic jack under the transmission and guide the unit into place. Be careful not to damage the oil filter, or oil pressure sending unit against the exhaust pipe. Be careful not to damage the distributor against the steering column.

18. Tighten the nuts for the front engine mounts.

19. Connect the wires for the back-up lights, start inhibitor switch (automatic transmission), and overdrive, it so equipped.

20. Install the brackets for the exhaust manifold and the automatic transmission filler tube. Install the rear engine mounts and rear crossmember, then tighten the nuts.

21. Remove the hydraulic jack from the transmission and the lifting apparatus from the engine. Connect the negative ground cable to the engine.

22. Connect the front universal joint to the transmission (or overdrive) flange. Connect the speedometer drive cable.

23. On manual transmission cars, connect the clutch cable and install the return spring. Adjust clutch free-play. See Section 7. On automatic transmission cars, connect the control rod to the selector lever, and the ground cable to the start inhibitor switch.

24. Connect the exhaust pipe to the exhaust manifold with new gaskets and tighten the nuts. Connect the EGR valve pipe.

25. Remove the jackstands from the jack attachments and lower the vehicle.

26. Connect the heater hoses. On models with power steering, install the pump and reservoir to the engine block and adjust the drive belt tension.

   a. On continuous (air-flow controlled) fuel injected models, install the thermal time switch and connect the hose for the brake booster. Install the throttle cable and connect the four fuel hoses to the injectors. Connect the control pressure regulator ground wire and the cold start injector, control pressure regulator, auxiliary air valve, temperature sensor, and thermal time switch leads. Connect the fuel hoses to the control pressure regulator and fuel distributor. Connect the hoses to the fuel filter, cold start injector, and the fuel return hose to the fuel distributor. Install the pipe between the air filter and the intake manifold.

   b. On electronic fuel injected models, place the injectors in their bayonet fittings with new rubber seals, and turn them clockwise to install. In addition, connect the fuel inlet line and the cold start valve hose to the distribution pipe and return line from the pressure regulator. Install the ground wire and the throttle cable bracket to the inlet duct, and connect the throttle cable. Connect the plug contact for the temperature sensor, cold start valve, throttle valve switch, fuel injectors, and distributor impulse. Install the pressure sensor vacuum hose, air cleaner, and intake hoses.

27. On all models, connect the positive crankcase ventilation hoses, and the distributor vacuum advance hose. Connect the vacuum hose for the power brake booster, and the oil pressure gauge hose at the pipe connection, if so equipped.

28. Install the electric cables for the starter, the coil high tension wire, the distributor lead, alternator wires, water and oil temperature sensors, and the lead for the oil pressure sensor, if so equipped.

29. Connect the positive lead to the battery.

30. Install the radiator and fan shroud, if so equipped, and the radiator cover plate. Install the expansion tank, the upper and lower radiator hoses, and, on automatic transmission cars, the transmission cooler lines. Make sure that the cooler lines clear the engine mounts and brake tubes by a generous ¾ in. (20mm)

31. Fill the crankcase and cooling system.

32. Install the hood. Install the gearshift lever.

33. Start the engine and check for leaks.

B21 and B23/B230 Series Engines

➡All wires and hoses should be labled at the time of removal. The amount of time saved during re-assembly makes the extra effort well worthwhile.

1. On cars equipped with manual transmission, remove the four retaining clips and lift up the shifter boot. Then, remove the snapring for the shifter.

2. Disconnect the negative cable first, then remove the battery.

3. Disconnect the windshield washer hose, engine compartment light wire and remove the hood.

4. Remove the overflow tank cap. Drain the cooling system by disconnecting the lower radiator hose and opening the engine drain cock (beneath the exhaust manifold).

✱✱CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

5. Remove the upper and lower radiator hoses. Disconnect the overflow hoses at the radiator. Disconnect PCV hose at the cylinder head.

6. On cars equipped with automatic transmission, disconnect the oil cooler lines at the radiator.

7. Remove the radiator and fan shroud.

8. Remove the air cleaner assembly and hose.

9. Disconnect the hoses at the air pump. Remove the air pump and drive belt.

10. Disconnect the vacuum pump hoses and remove the vacuum pump. Disconnect the power brake booster vacuum hose.

11. Remove the power steering pump, drive belt and bracket. Position to one side.

12. On cars equipped with air conditioning, remove the crankshaft pulley (5mm Allen wrench), and compressor drive belt. Then install the pulley again for reference. Remove the air conditioning wire connector and the compressor from its bracket and position to one side. Remove the bracket. Note that you are simply unbolting and moving various air conditioning components; it IS NOT necessary to discharge the system.

13. Disconnect the vacuum hoses from the engine. Disconnect the carbon canister hoses.

14. Disconnect the distributor wire, high tension lead, starter cables, and the clutch cable clamp.

15. Disconnect the wiring harness at the voltage regulator. Disconnect the throttle cable at the pulley; and the wire for the compressor at the intake manifold solenoid.

16. Remove the gas cap. Disconnect the fuel lines at the filter and return pipe.

17. At the firewall, disconnect the electrical connectors for the ballast resistor, and relays. Disconnect the heater hoses.

18. Disconnect the micro-switch at the intake manifold, and all remaining harness leads to the engine.

19. Drain the crankcase.

✱✱CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

20. Remove the exhaust manifold flange retaining nuts. Loosen the exhaust pipe clamp bolts and remove the bracket for the front exhaust pipe mount.

21. On cars equipped with automatic transmission, place the gear selector lever in PARK and disconnect the gear shift control rod from the transmission.

22. On manual transmission cars, disconnect the clutch cable. Then loosen the setscrew, drive out the pivot pin, and remove the shifter from the control rod.

23. Disconnect the speedometer and the driveshaft from the transmission.

24. On overdrive equipped models, disconnect the control wire from the shifter.

25. Jack up the front of the car and place jack stands beneath the reinforced box member areas to the rear of each front jacking attachment. Then, using a floor jack and a wooden block, support the weight of the engine beneath the transmission.

26. Remove the bolts for the rear transmission mount. Remove the transmission support crossmember.

27. Lift out the engine and support on suitable rack or stand.

To install:

28. After lifting the motor into position within the car, reinstall the rear transmission mount and secure the bolts. Lower or adjust the jack as necessary to position the motor on the front mounts.

29. Attach the speedometer cable and driveshaft to the transmission. If equipped with overdrive, reconnect the control wire from the shifter.

30. On manual transmission cars, attach the shifter to the control rod. Install the pivot pin, tighten the set-screw, and hook up the clutch cable.

31. On cars with automatic transmission, reconnect the gear shift control rod.

32. Install and tighten the front motor mount bolts.

33. Install the bracket for the front exhaust pipe mount. Install and tighten the exhaust manifold flange retaining nuts. Tighten the exhaust pipe clamp bolts.
34. Beginning with the larger, easily identified harnesses, reconnect electrical circuits at the firewall and the engine. Check the firewall area for ballast resistor, and relays. Check also for correct hook ups at the voltage regulator, distributor and starter. Smaller harnesses and single wires also run to the micro-switch at the intake manifold and the AC solenoid on the intake manifold.
35. Connect and secure the heater hoses.
36. Re-attach the fuel lines at the filter and return pipe; reinstall the gas cap.
37. Connect the throttle cable at the pulley. Install the clutch cable clamp if so equipped.
38. Connect all engine vacuum hoses and connect the charcoal cannister.
39. On cars equipped with air conditioning, reinstall the compressor bracket and the compressor. Reconnect the compressor wiring. Once again, remove the crankshaft pulley, install the AC belt and reinstall the pulley in its correct location. Adjust the AC belt to the correct tension.
40. Reinstall the power steering pump, bracket and belt. Adjust the belt to the proper tension.
41. Attach the vacuum pump and its hoses. Connect the power brake booster vacuum hose.
42. Reattach the air pump, connect the hoses and install the belt. Set the belt to the correct tension.
43. Install the air cleaner assembly and hoses.
44. Reinstall the radiator and fan shroud. On cars with automatic transmission, connect the transmission cooler lines to the radiator.
45. Connect the upper and lower radiator hoses, attach the overflow line and install the overflow tank cap. If not already done, close the draincocks on the engine block.
46. Refill oil and coolant to the proper levels. Connect the PCV hose to the cylinder head.
47. Reinstall the hood. Connect the wire for the underhood light and the windshield washer hoses.
48. Install and reconnect the battery.
49. On manual transmission cars, reinstall the shifter and its snap ring. Secure the shifter boot and its four retaining clips.
50. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.
51. Start the engine, allow it to run at idle and check for leaks. Make needed adjustments to throttle cable, clutch, and idle speed as necessary. Check ALL fluid levels and top off as needed.

B234 Engine

1. Disconnect the battery, negative cable first.
2. Detach the ground connection at the top of the side frame rail.
3. Release the bolted joint at the exhaust manifold front bracket.
4. Attach the sling or lifting equipment to the rear of the motor and support the motor from above. Release any wiring harnesses from their clips and place the wiring out of the way of the lifting gear.
5. Remove the splash guard under the engine, drain the engine oil and remove the air intake duct.

✲✲CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

6. Undo the wiring clips on the front crossmember and right frame rail. Release the battery from the clips and work the wiring free of the roll bar.
7. If the vehicle is equipped with air conditioning, remove the compressor from its mount and position it out of the way. Do not disconnect any lines or hoses on the compressor.
8. Remove the bottom nut on the left engine mount.
9. On manual transmission cars, remove the clutch slave cylinder and position out of the way. Be careful of the rubber boot; it retains the piston within the cylinder.
10. Separate the front and rear universal joints. Unbolt the center support bearing and withdraw the driveshaft towards the rear of the car.
11. Cut the rear cable tie holding the transmission wiring and separate the connectors.
12. For cars with manual transmission, the gear lever is removed by removing the locking bolt, removing the pivot pin between the lever and the selector rod and removing the circlip from the lever sleeve. Push the shift lever up and remove the bushings. For cars with automatic transmissions, the selector lever is disconnected by removing the clips from the joints between the lever and the selector rod. Withdraw the arm from the mounting.
13. Release the bolted joint at the front of the catalytic converter and release the oxygen sensor wire from the rear clip.
14. Remove the front exhaust pipe by removing the bolts at its joint to the exhaust manifold.
15. If equipped with automatic transmission, disconnect the oil lines at the transmission and plug the lines.
16. Remove the transmission crossmember. As soon as it is removed, position a floor jack below the transmission to support it.

➡The following steps are in the upper engine area. It may be helpful to temporarily remove the hoist equipment for access. The hoist will need to be reinstalled later in the removal.

17. Remove the upper heat shield from the exhaust manifold. Remove the air hose from the lower heat shield.
18. Remove the top nut from the right motor mount.
19. Open the draincock on the right side of the engine block and drain the coolant into a container.
20. Label and remove the wiring from the distributor cap. Remove the cap and rotor and disconnect the braided engine ground wire.
21. Disconnect the wire to terminal 1 on the coil. Separate the wiring connectors on the right shock tower and release the cable clips on the firewall. Free the wiring from the clips.

22. Disconnect the heater hoses on the left firewall.
23. Release the fuel line connection at the left firewall and attend to any fuel spillage immediately. Plug the fuel lines.
24. Disengage the wiring connector on the left side of the firewall and free the wires from the clips.
25. Disengage the air mass meter, its wiring and the hoses connected to the air intake.
26. Release the throttle cable from the pulley.
27. Remove the vacuum hose to the brake booster from the intake manifold. Remove the evaporation hose from the intake manifold and the return line from the fuel distributor.
28. At the left shock tower, release the engine wiring harness from its clips and disconnect the wiring connectors. Remove the power steering reservoir from its clips.
29. Disconnect the coolant hoses at the thermostat housing and at the water pump.
30. Remove the drive belts.
31. Remove the radiator fan, the fan shroud and the drive pulley.
32. Remove the power steering pump from its mount. Place the pump on paper or rags atop the left shock tower. Do not disconnect any hoses from the pump.
33. If the lifting equipment was removed earlier, reconnect it.
34. Check the surroundings of the engine and transmission unit. With the exception of the jack and the motor mounts, there should be nothing connecting the engine/trans assembly to the body of the car. Take slight tension on the hoist and check that the engine is balanced. Reposition the lift points if the engine is not balanced.
35. Lift out the engine and the gearbox, being very careful of the radiator and surrounding components. Support the engine on appropriate stands.
36. When reinstalling, check the position and security of the hoist equipment. Lift the engine and gearbox into place in the body of the car.
37. Guide the engine mounts into place and support the transmission on the floor jack.
38. Replace the transmission crossmember and make sure the wiring for the oxygen sensor runs above the crossmember. Remove the floor jack when the crossmember is secure. The engine hoisting equipment may also be removed.
39. Use a new gasket and attach the exhaust pipe to the manifold. Attach the wire to the oxygen sensor.
40. Reconnect the shifting mechanism to the transmission.
41. Reconnect the transmission wiring and secure the harness with new wire ties.
42. Install the driveshaft. Tighten the front and rear universal joints and attach the center support bearing.
43. On manual transmission car connect the clutch slave cylinder. On automatic transmissions, connect the oil cooler lines.
44. Install the lower nut for the left motor mount. On cars with air conditioning, remount the compressor on its brackets.
45. Track the wiring between the anti-roll bar and the front crossmember. Install the cable clips on the crossmember and right-side frame rail. Install the splash guard under the car. Reconnect the wiring to the ground connection on the right frame rail.
46. Install the nut on the top of the right engine mount. Install the upper heat shield on the manifold and the air tube to the lower heat shield.
47. Reconnect the coolant hoses. The bottom hose connects to the water pump and the upper hose to the thermostat housing.

****WARNING**

Note the marking on the upper hose. The hose must run at least one inch away from the alternator belt.

48. Remount the power steering pump. Install its belt (and the air conditioning belt if so equipped) and adjust to the correct tension.
49. Install the fan, pulley and shroud. Secure the wiring below the fan with new wire ties. Install the drive belt and adjust to the correct tension.
50. Reconnect the rear wiring harnesses on the firewall. Plug all connectors carefully and secure harnesses within the clips. Don't forget the wire to terminal 1 on the coil.
51. Reinstall the distributor rotor, cap and wires. Connect the braided engine ground cable.
52. Reconnect the wiring at the left shock tower. Make sure the wiring is secure in its clips. Install the power steering reservoir.
53. At the intake manifold, connect the vacuum line to the brake booster, the evaporation line and the return line for the fuel distributor.
54. At the left side of the firewall, attach the heater hoses and connect the fuel line.
55. Reattach the throttle cable to the pulley.
56. Install the air mass meter with its hoses and connections.
57. Fill the engine with proper coolant, set the heater to its hottest setting and check the system for leaks.
58. Install the engine oil.
59. Reconnect the battery leads (positive first) and the protective cap on the terminals.
60. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.
61. Start the engine and check for leaks. This engine may be somewhat noisy when started; the noise will disappear as the tappets fill with oil.

B27F, B28F and B280F Engines

See Figures 36 and 37

➡All wires and hoses should be labeled at the time of removal. The amount of time saved during reassembly makes the extra effort well worthwhile.

1. On cars equipped with manual transmission, remove the shifter assembly. From underneath, loosen the setscrew and drive out pivot pin. Pull up the boot, remove the reverse pawl bracket and snap ring for the shifter, and lift out the shifter.
2. Disconnect the negative cable first, then remove the battery.
3. Disconnect the windshield washer hose and engine compartment light wire. Scribe the outline of the hood hinges on the hood and remove the hood.
4. Remove the air cleaner assembly. On B28, remove the intake air preheating assembly.
5. Remove the splash guard under the engine.

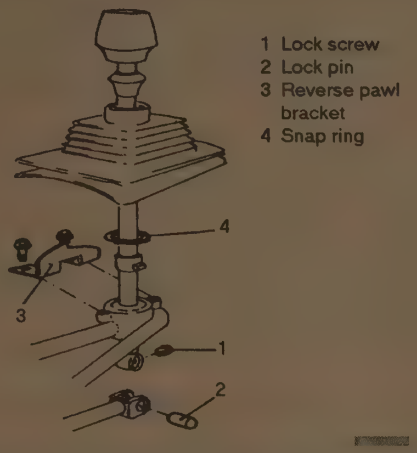


Fig. 36 Exploded view of the gear shifter mechanism

6. Drain the cooling system by disconnecting the lower radiator hose and opening the drain cocks on both sides of the cylinder block.

**CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

7. Remove the overflow tank cap. Remove the upper and lower radiator hoses, and disconnect the overflow hoses at the radiator.
8. On cars equipped with automatic transmission, disconnect the transmission cooler lines at the radiator.
9. Remove the radiator, fan shroud and grille.

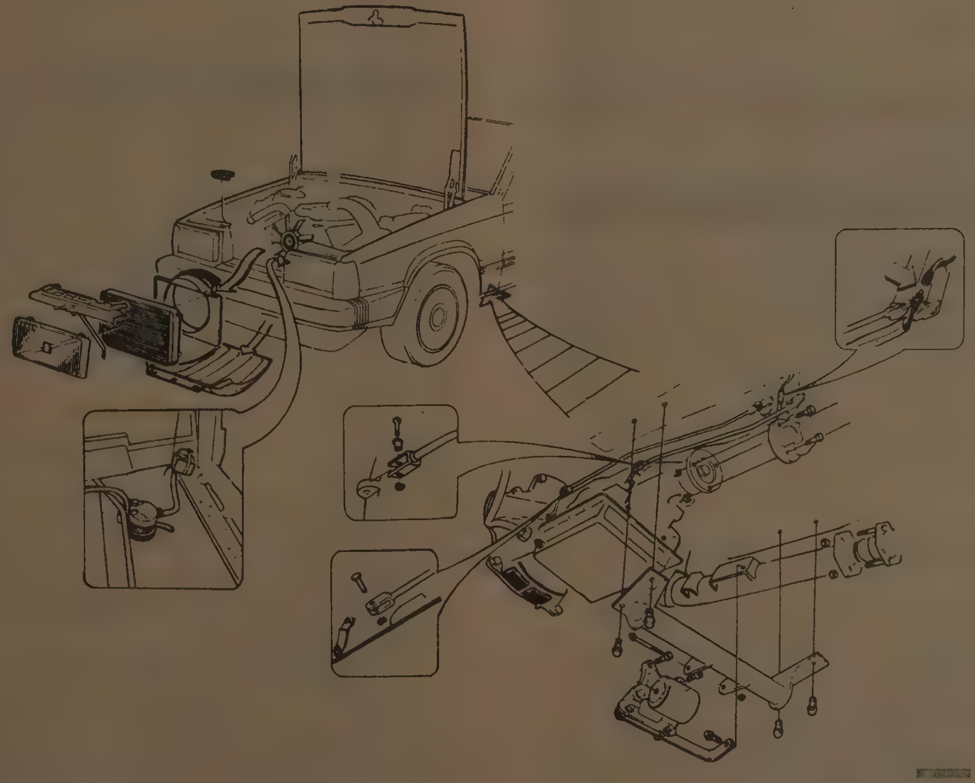


Fig. 37 Exploded view of components that must be removed for engine removal — 760 shown, others similar

10. Disconnect heater hoses, power brake hose at the intake manifold and the vacuum pump hose at the pump. Remove the vacuum pump and O-ring in the valve cover. Remove the gas cap.

****CAUTION**

The fuel system retains high pressure. Observe no smoking/no open flame rules. Discharge pressure slowly. Be prepared to contain spillage.

11. At the firewall, disconnect the fuel lines at the filter and the return pipe. Disengage the relay connectors and all other wire connectors. Disconnect the distributor wires.
12. Disconnect the evaporative control carbon canister hoses and the vacuum hose at the EGR valve.
13. Disengage the voltage regulator wire connector.
14. Disconnect the throttle cable (and kickdown cable on automatic transmission cars), the vacuum amplifier hose at the T-pipe, and the hose at the wax thermostat.
15. Disconnect the air pump hose at the backfire valve, the solenoid valve wire, and the micro-switch wire.
16. Remove the exhaust manifold flange retaining nuts (both sides). On the B28, disconnect the exhaust downpipe above the catalytic converter and remove it after disconnecting the oxygen sensor.
17. On cars equipped with air conditioning, remove the compressor and drive belt, and place it to one side. Note that you are simply unbolting and moving various AC components; it IS NOT necessary to discharge the system. Do not disconnect the refrigerant hoses.
18. Drain the crankcase.

****CAUTION**

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

19. Remove the power steering pump, drive belt, and bracket. Position to one side.
20. From underneath, remove the retaining nuts for the front motor mounts.
    a. On B27 California models equipped with a catalytic converter, remove the front exhaust pipe.
    b. On B27 49 states models, remove the front exhaust pipe hangers and clamps and allow the system to hang.
    c. On the B28 and B280, disconnect the exhaust system clamp from the transmission and allow exhaust to hang.
21. On cars equipped with automatic transmission, place the shift lever in PARK. Disconnect the shift control lever at the transmission.
22. On manual transmission cars, disconnect the clutch slave cylinder from the bell housing. Leave the cylinder connected to its hoses and secure the cylinder out of the way.
23. Disconnect the speedometer cable and driveshaft at the transmission.
24. Jack up the front of the car and place jack stands beneath the reinforced box member area to the rear of each front jacking attachment. Using a floor jack and a thick, wide wooden block, support the weight of the engine beneath the oil pan.
25. Remove the bolts for the rear transmission mount. Remove the transmission support crossmember.
26. Lift out the engine and transmission.
27. Support the engine on a suitable rack or stand.

To install:

28. Lower the engine and transmission into the car. Support the weight of the engine with the floor jack and a thick, wide piece of wood under the oil pan.
29. Replace the transmission crossmember; install and tighten the bolts.
30. At the transmission, connect the speedometer cable and driveshaft.
31. On manual transmission cars, reattach and secure the clutch slave cylinder. On automatic transmissions, reconnect the shift control lever.
32. Install and secure exhaust system pieces as necessary. Check for proper placement of all brackets, mounts and clamps. Check for interference between exhaust pipes and bodywork.
33. Install the front motor mount retaining nuts.
34. Install the power steering pump, bracket, and drive belt. Adjust the belt to the proper tension.
35. If equipped with air conditioning, reinstall the compressor and drive belt. Adjust the belt to the proper tension.
36. Reconnect the exhaust manifold flange retaining nuts on both sides of the motor and and secure. On B28/B280, reconnect the oxygen sensor.
37. Re-attach the air pump hose to the backfire valve, connect the solenoid valve wire, and the wire to the micro-switch.
38. Reconnect the hose to the wax thermostat, the vacuum amplifier hose and the throttle cable. On automatic transmission cars, reconnect the kick-down cable.
39. Attach the wiring to the voltage regulator and replace the hoses to the carbon canister. Install the vacuum hose to the EGR valve.
40. At the firewall, connect the wiring to all relays and components, beginning with the larger harnesses first. Reinstall the distributor wiring.
41. Connect and secure all fuel lines at the filter and the return pipe. These are high pressure lines; make sure the fittings are tight and will not leak. Reinstall the gas cap.
42. Reinstall the vacuum pump and O-ring, and the pump hose. Connect the heater hoses; connect the power brake hose to the intake manifold.
43. Install the radiator, fan shroud and grille. On cars with automatic transmission, reconnect the transmission cooler lines to the radiator.
44. Install the upper and lower radiator hoses, the overflow hoses and replace the overflow tank cap. If not already done, close the drain cocks on both sides of the engine.
45. Attach the under-engine splash guard. Reinstall the air cleaner assembly, and, on B28/B280, the intake air preheating assembly.
46. Remount the hood and attach the washer lines and under hood light wire.
47. Add oil and coolant to specified levels.

48. Reinstall the battery. Secure the battery hold-down clamp and the wiring terminals.

49. On cars with manual transmissions, reinstall the shifter with particular attention to the snapring and the setscrew which locks the pivot pin.

50. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

51. Start the engine, allow it to run at idle and check for leaks. Make needed adjustments to throttle cable, clutch, and idle speed as necessary. Check ALL fluid levels and top off as needed.

D24 and D24T Engines

◆ See Figures 38 and 39

➡Cleanliness is extremely important when working on diesel fuel systems. Wipe off all line joints before disconnecting and plug open lines immediately. If drained fuel is to be re-used, collect in clean container and cap immediately. All wires and hoses should be labled at the time of removal. The amount of time saved during reassembly makes the extra effort well worthwhile.

1. Matchmark and remove the hood.
2. Disconnect the negative battery terminal.
3. Drain the radiator coolant.

✱✱CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Remove the four clips and pull up the rubber boot on the shift lever.
5. Disengage the back-up light and overdrive connector if so equipped.
6. Remove the bracket for the reverse inhibitor.
7. Release the lock ring on the shift lever.
8. Move the lock ring, rubber ring, and plastic journal up on the lever.

➡On cars with automatic transmissions place the shift lever in P before disconnecting.

9. Disconnect the top and bottom radiator hoses.
10. Disconnect the lower hose at the cold start device, and drain the coolant into a suitable container.
11. On vehicles with automatic transmissions, remove the cooling lines from the radiator.
12. Disconnect the expansion tank hose.
13. Unbolt and remove the grille, the radiator and the fan shroud.
14. Disengage the electrical connections at the firewall.
15. Remove the heater hoses at the control valve.
16. Disconnect the hose from the vacuum pump.
17. Disconnect the accelerator cable from the pulley and bracket. On automatic transmission-equipped cars, disconnect the kickdown cable.
18. Disconnect the vacuum line to the brake booster.
19. Disconnect the fuel supply line at the filter and the return line at the injection pump.

➡Thoroughly clean all connections prior to disconnecting them.

20. Plug all fuel lines to prevent dirt from entering them.
21. Disconnect the wires at the main terminal.
22. Disconnect the glow plug relay.
23. Remove the relay retaining screws and hang the relay and the wire bundle on the engine.
24. Remove the power steering pump and brackets, and use a piece of wire to tie it out of the way. It is not necessary to disconnect the hoses from the pump, but DO NOT allow the pump to hang by its hoses. If so equipped, detach the air conditioner compressor from its mounts and tie it out of the way. DO NOT disconnect any hoses to the compressor and DO NOT allow the compressor to hang by its hoses.
25. Remove the starter wires and the battery ground strap.
26. Remove the fan, spacer, pulley and drive belts.
27. Remove the air cleaner and all necessary hoses.
28. Disconnect the alternator wires.
29. Disconnect the exhaust pipe at the front exhaust manifold.
30. Drain the engine oil.

✱✱CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

31. Disconnect the exhaust pipe at the rear exhaust manifold.

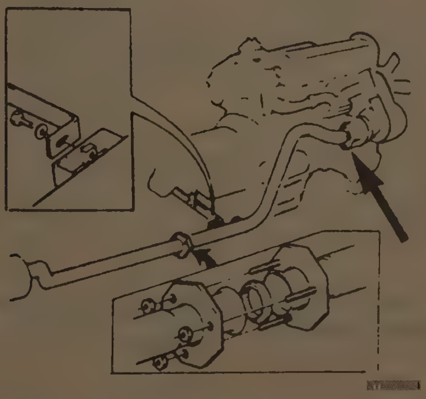


Fig. 38 Disconnect the exhaust pipe and bracket as shown

32. On D24T models, remove the inlet hose from the turbo pipe, and the snapring from the turbo intake pipe. Remove the compressor intake pipe and plug the hole immediately with a clean rag. Disconnect the oil return pipe bolts, and move the return pipe aside. Plug the hoses. Remove the oil delivery pipe from the turbo unit, and plug the hoses. Remove the compressor and exhaust pipes from the turbo unit, and remove the turbocharger.
33. Disconnect the clutch cable, return spring, vibration damper, and rubber buffer.
34. Pull out the clutch cable from the clutch lever and housing.
35. Disconnect the speedometer from the transmission.

➡On cars with automatic transmissions disconnect the gear shift control rod from the transmission.

36. Disconnect the shift lever and push it up into the car.
37. Remove the driveshaft from the transmission.
38. Support the transmission with a jack and remove the rear crossmember.
39. Remove the engine mounts.
    a. Left side: Remove the nuts from the front axle member.
    b. Right side: Remove the lower nut from the rubber pad.
40. Gently put tension on your engine removal hoist.
41. Remove the left engine mount assembly.
42. Tilt the engine and remove it using the proper lifting device.
43. Support the engine on a suitable rack or stand.

To install:

44. After positioning the engine in the car, attach the left engine mount to the block, gently lower the engine to its final position and secure both the left and right side engine mount nuts.
45. With the transmission resting on the jack, install the rear transmission crossmember.

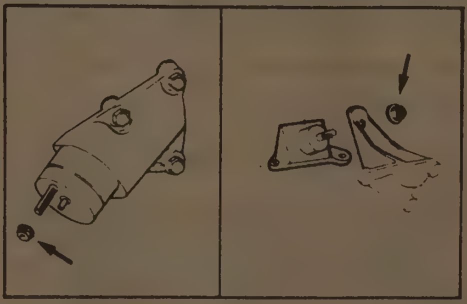


Fig. 39 Remove the retaining nuts from the left and right engine mounts

46. Reconnect the driveshaft to the transmission. On automatic transmissions, reconnect the gear shift control rod to the transmission. On manual shift cars, reconnect the clutch cable to the lever and housing, remembering to install the return spring, vibration damper and buffer. Reconnect the speedometer cable.
47. On D24T models, reinstall the turbocharger unit, using new gaskets. Install the compressor and exhaust pipes. Remove the plugs from the lines and attach the oil delivery and oil return lines to the turbo unit. Remove the plugs and install the compressor intake pipe and air inlet hose.
48. Connect the exhaust pipes to the front and rear exhaust manifolds.
49. Connect the wiring to the alternator.
50. Replace the air cleaner assembly and its hoses and ductwork.
51. Install the fan, spacer, pulley and drive belts. Adjust the belts as necessary.
52. Connect the wiring to the starter and the battery ground strap.
53. Remount the power steering pump and brackets and, if equipped, the air conditioner compressor. Install the belts and adjust to the proper tension. Check the hoses for proper routing; make sure there is no possibility of the hoses rubbing on anything nearby.
54. Reinstall the glow plug relay at the firewall and connect its wiring. Attach the wiring at the main terminal.
55. Remove the plugs from the fuel delivery and return lines and connect them to the proper ports. Maintain extreme cleanliness throughout this operation.
56. Reconnect to vacuum line to the brake booster.
57. Attach the throttle cable to the pulley and bracket. Reattach the kickdown cable on cars with automatic transmissions.
58. Reconnect the hose to the vacuum pump. Attach and secure the heater hoses at the control valve.
59. Reconnect the electrical harnesses and wires at the firewall. Begin with the larger harnesses first.
60. Reinstall the radiator, fan shroud and grille. Connect the expansion tank hose. If equipped with automatic transmission, reconnect the oil cooler lines at the radiator.
61. Attach and secure the upper and lower radiator hoses and the lower hose to the cold start device.
62. Reinstall the shift lever assembly and reverse inhibitor. Connect the wiring for the reverse lights and, if equipped, the overdrive. Replace the shifter boot and secure with the four clips.
63. Reconnect the negative battery cable. Install the hood and connect the underhood light and the washer lines.
64. Install oil and coolant to specified levels.
65. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.
66. Start the engine, allow it to run at idle and check for leaks. Make needed adjustments to throttle cable, clutch, and idle speed as necessary. Check ALL fluid levels and top off as needed.

Rocker Arm (Valve) Cover

REMOVAL & INSTALLATION

➧ See Figures 40, 41, 42, 43 and 44

1. Disconnect and reposition as necessary any vacuum or PCV hoses that obstruct the valve cover(s).
2. Label and remove any wires (spark plug wiring, ground wires, etc.) that may obstruct the valve cover(s).
3. Unbolt and remove the valve cover(s). If the cover is to be off for a period of hours or days, cover the exposed rockers with a rag to prevent dirt accumulation.

➡Do not pry the cover off if it seems stuck. Instead, gently tap around each cover with a rubber mallet until the old gasket breaks loose. A bent valve cover is extremely hard to straighten and will provide endless oil leaks for you to pursue.

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Fig. 40 Unbolt the cover, setting aside any components that must also be loosened or removed during the procedure

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Fig. 41 This ground wire should be labeled so you don't forget to put it back in place upon reinstallation

To install:

4. Peel and if necessary scrape off the old gasket material without gouging the aluminum mating edge of the valve cover. The surface should be completely free of material before installing the new gasket.
5. Always use a new valve cover gasket. Install the valve cover(s) and tighten cover bolts to 3 ft. lbs. (4 Nm). Do not overtighten the bolts; you may distort the cover and cause oil leaks.

➡On B234 engines, silicone sealant must be applied at the front and rear camshaft bearing caps before the gasket is installed.

6. Connect and reposition all vacuum and PCV hoses, and reconnect any electrical wires that were removed.

Rocker Shaft and Arm Assembly

REMOVAL & INSTALLATION

B20 and B30 Engines

1. Remove the retaining screws and the valve cover and gasket.
2. Remove the rocker shaft-to-cylinder head bolts and lift out the shaft and rocker arms as a unit.
3. Lift out the pushrods, keeping them in order (an upside down shoebox with numbered holes makes an excellent holder) and check them for straightness by rolling them on a flat surface. Replace any bent pushrods.
4. Inspect the rocker shaft arms. If the shaft and rockers are coated with baked-on sludge, oil may not be reaching them. Clean out the oil feed holes in the rocker shaft with 0.020 in. (0.5mm) wire (piano wire). If the clearance between the rocker arms and shaft exceeds 0.004 in. (0.1mm), the rocker arm needs to be rebushed. The rocker arm bushings are press fitted, and are removed with a drift. When pressing a new bushing, make sure that the oil hole in the bushing aligns with the hole in the arm.
5. Position the pushrods on their respective lifters. Install the rocker shaft and arm assembly on the head, and install the retaining bolts. Use a three step tightening procedure. Working from front to rear, tighten all the retaining bolts to 10 ft. lbs. (14 Nm). Following the same pattern, tighten all the bolts to 15 ft. lbs. (20 Nm), then make a final pass tightening all the bolts to 20 ft. lbs. (27 Nm).
6. Check to see that valve lash has remained within specifications. Adjust valve lash, if necessary, as outlined in Section 1.
7. Install the valve cover with a new gasket, and tighten the valve cover retaining screws. Do not overtighten the valve cover bolts.

B27F, B28F and B280F Engines

➧ See Figures 45 and 46

1. Disconnect the negative battery cable.
2. Disengage the ignition system connector located on the right shock tower.
3. Using a 5mm Allen wrench, disconnect the control pressure regulator and lay the regulator on the intake manifold.

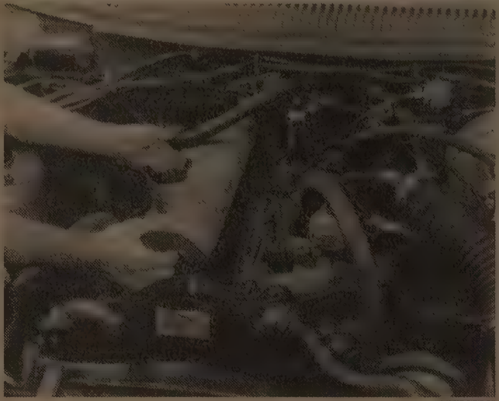

Fig. 42 If necessary tap the unfastened valve cover to loosen the gasket, then carefully remove and set aside in a safe location

Fig. 43 Completely remove the old gasket material to ensure a good seal for the new gasket

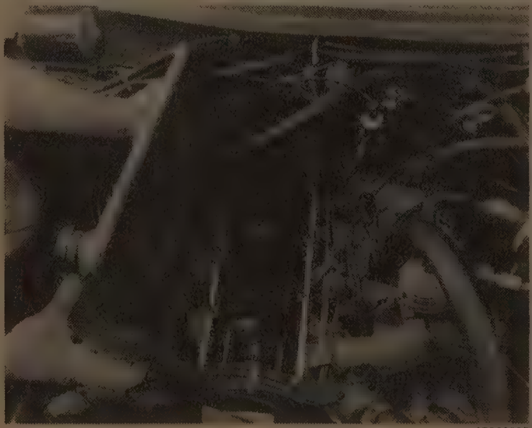

Fig. 44 Install the cover and tighten the fasteners to the proper torque specification

4. Remove the oil filler cap and hoses.
5. Remove the vacuum pump (left rear of engine); on B27, remove air pump if so equipped. Remove the air inlet duct running to the top center of the motor.
6. On air conditioned models, remove the AC compressor. On B27s, remove the rear bracket. DO NOT loosen or remove any hoses at the compressor; simply remove the entire unit and use wire to tie it out of the way. Do not allow the compressor to hang by its hoses.
7. Loosen the valve cover bolts and remove the valve covers.
8. The rocker arm bolts double as cylinder head bolts. When loosening, follow the cylinder head bolt tightening sequence diagram. If removing both rocker shafts, mark them left and right.

➡Do not jar or strike the head while rockers and bolts are out, as the cylinder liner O-rings may break. If this happens, the engine requires a full tear-down to clean coolant out of crankcase and install new seals.

9. To install, place the rocker shaft in position on the proper side of the engine. Install the bolts finger-tight, then use a three step tightening procedure. Tighten the bolts in the order shown in the illustration.
   First tightening: 7 ft. lbs. (9 Nm)
   Second tightening: 22 ft. lbs. (30 Nm)
   Third tightening: 44 ft. lbs. (60 Nm)
10. Reinstall valve covers with new gaskets. Replace all components in reverse order, remembering to adjust the belts. When reinstalling the vacuum pump, use a new gasket and make sure the pump contacts the top side of the camshaft.

Thermostat

To operate at peak efficiency, an engine must maintain its internal temperatures within certain upper and lower limits. The cooling system circulates fluid around the combustion cylinders and directs this heated fluid to the radiator, where the heat is exchanged into the airflow created by the fan and the motion of the car.

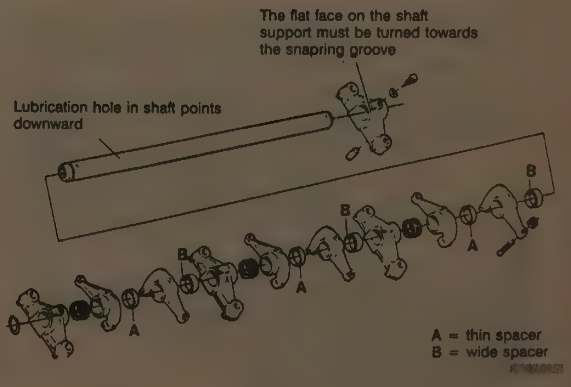
The flat face on the shaft support must be turned towards the snapring groove
Lubrication hole in shaft points downward
B
B
B
A
A
A
A = thin spacer
B = wide spacer

Fig. 45 Rocker arm shaft assembly — B28 and B280 engines

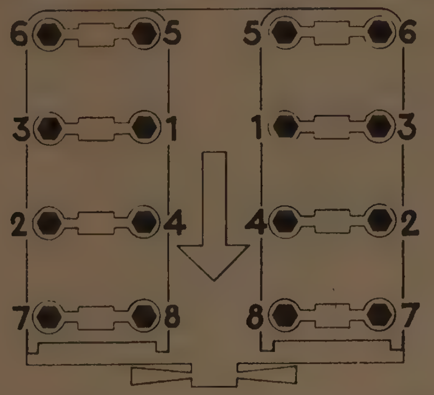

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Fig. 46 Loosening/tightening sequence for the cylinder head/rocker assembly bolts — B27, B28 and B280 engines (arrow points to front)

While most people realize that an engine running too hot (overheated) is a sign of trouble, few know that an engine can run too cool as well. If the proper internal temperatures are not achieved, fuel is not burned efficiently, and the lubricating oil does not reach its best working temperature. While a too cold condition is rarely disabling, it can cause a variety of problems which can be mistaken for tune-up or electrical causes.

The thermostat controls the flow of coolant within the system. It reacts to the heat of the coolant and allows more fluid (or less) to circulate. Depending on the amount of fluid being circulated, more or less heat is drawn away from the inside of the engine. While we are beyond the days of having to install different thermostats for summer and winter driving, it is wise to check the function of the thermostat periodically. Special use of the car such as trailer towing or carrying heavy loads may require the installation of a thermostat with different temperature characteristics.

REMOVAL & INSTALLATION

➧ See Figures 47, 48, 49, 50, 51, 52 and 53

1. Disconnect the lower radiator hose and drain the cooling system.
2. Remove the two fasteners securing the thermostat housing to the cylinder head on gasoline engines and to the block on the diesel. Carefully lift the housing free. Before removing the thermostat, look at it carefully to know which end is up. It is possible to install one upside down. Pay attention!
3. Remove all old gasket material from the mating surfaces and remove the thermostat. Do not use metal blades to scrape these surfaces; you may gouge the metal and cause a leak. Use a wooden or plastic scraper.
4. Test the operation of the thermostat by immersing it in a container of heated water. Replace any thermostat that does not open at the correct temperature. Most thermostats will begin to open at approximately 190°F (88°C).
5. Place the thermostat, with a new gasket, in position. Fit the thermostat housing and hand-tighten the bolts. Tighten the

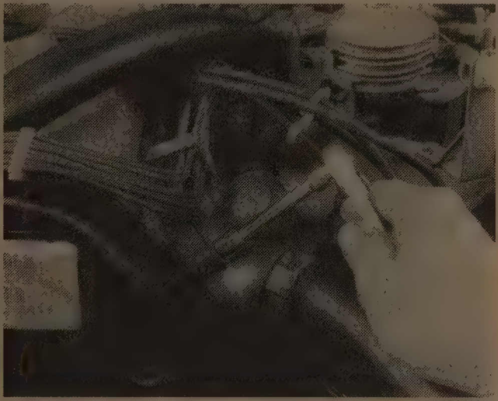

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Fig. 47 Remove the two fasteners that hold the thermostat housing to the cylinder head — B21FT engine shown

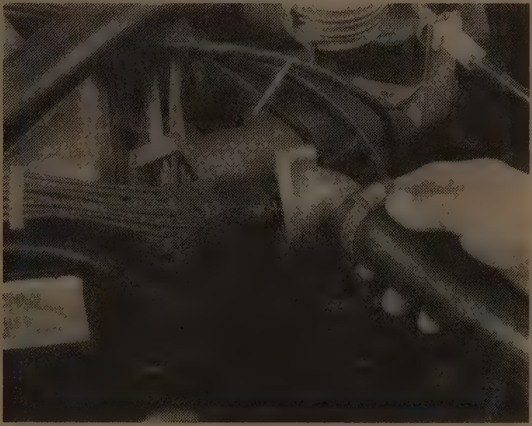

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Fig. 48 Pull away the housing from the cylinder head to access the thermostat inside

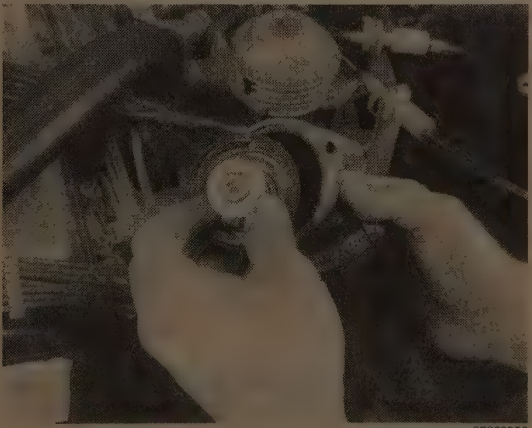

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Fig. 49 Manipulate the housing up in your hand and pull out the thermostat from inside

Fig. 50 Remove and discard the old gasket, then scrape clean the mating surfaces without gouging the aluminum

bolts ¼ turn past finger-tight; overtightening can crack the brittle housing.

➡Cars with diesel engines require a different bleeding procedure. Please refer to the Cooling System portion of Section 1.

6. Connect the lower radiator hose and replace the coolant. On gasoline engine cars, leave the radiator cap off, start the engine and allow it to reach normal operating temperature. Inside the car place the heater temperature selector to full hot and turn on the blower. This allows the coolant to circulate fully throughout the system and purge any air bubbles which may be trapped. After a few minutes (during which you may observe air bubbles in the radiator neck) shut the engine off, top up the coolant and secure the radiator cap.

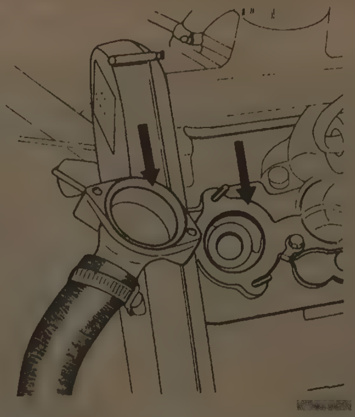

Fig. 51 Access the thermostat in the location shown. Arrows indicate areas to scrape clean prior to new gasket installation — B23 and B230 engines

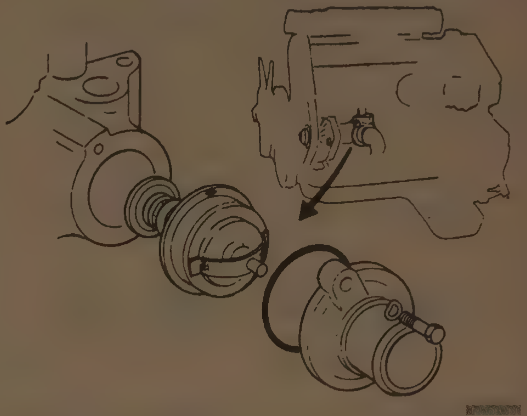

Fig. 52 Exploded view of thermostat mounting — make sure you install it in the correct direction

Intake and Exhaust Manifolds

On early carbureted Volvos, the intake and exhaust manifolds are cast integrally. A preheating chamber is located within the combination manifold. The chamber's function is to transfer the heat from the exhaust ports to the fuel-air mixture in the intake manifold for improved cold weather operation. As the manufacturer moved to fuel injection for the U.S. cars in the early 1970s, the few remaining carbureted cars used separate intake and exhaust manifolds.

On all fuel injected and diesel Volvos, the intake manifold (inlet duct) and exhaust manifold are separate units. The inlet duct is constructed of a light aluminum alloy, while the exhaust manifold is cast iron.

Combination Manifold (Carbureted Engines)

REMOVAL & INSTALLATION

1. Remove the exhaust manifold preheating plate. Remove the nuts and disconnect the exhaust pipe from the exhaust manifold.
2. Remove the air cleaner. Disconnect the throttle, choke, and downshift linkage, if so equipped. Label and disconnect the positive crankcase ventilation hoses, and the vacuum hoses for the distributor advance, and power brake, if so equipped.
3. Remove the nuts and slide the combination manifold off the studs. Remove and discard the old manifold gasket.
4. To install, reverse the above procedure. Remember to use a new manifold gasket and exhaust pipe flange gasket in assembly. Most manifold gaskets have definite inside and outside faces; make sure it is correctly positioned. Tighten the manifold retaining nuts to 13-16 ft. lbs. (18-22 Nm).

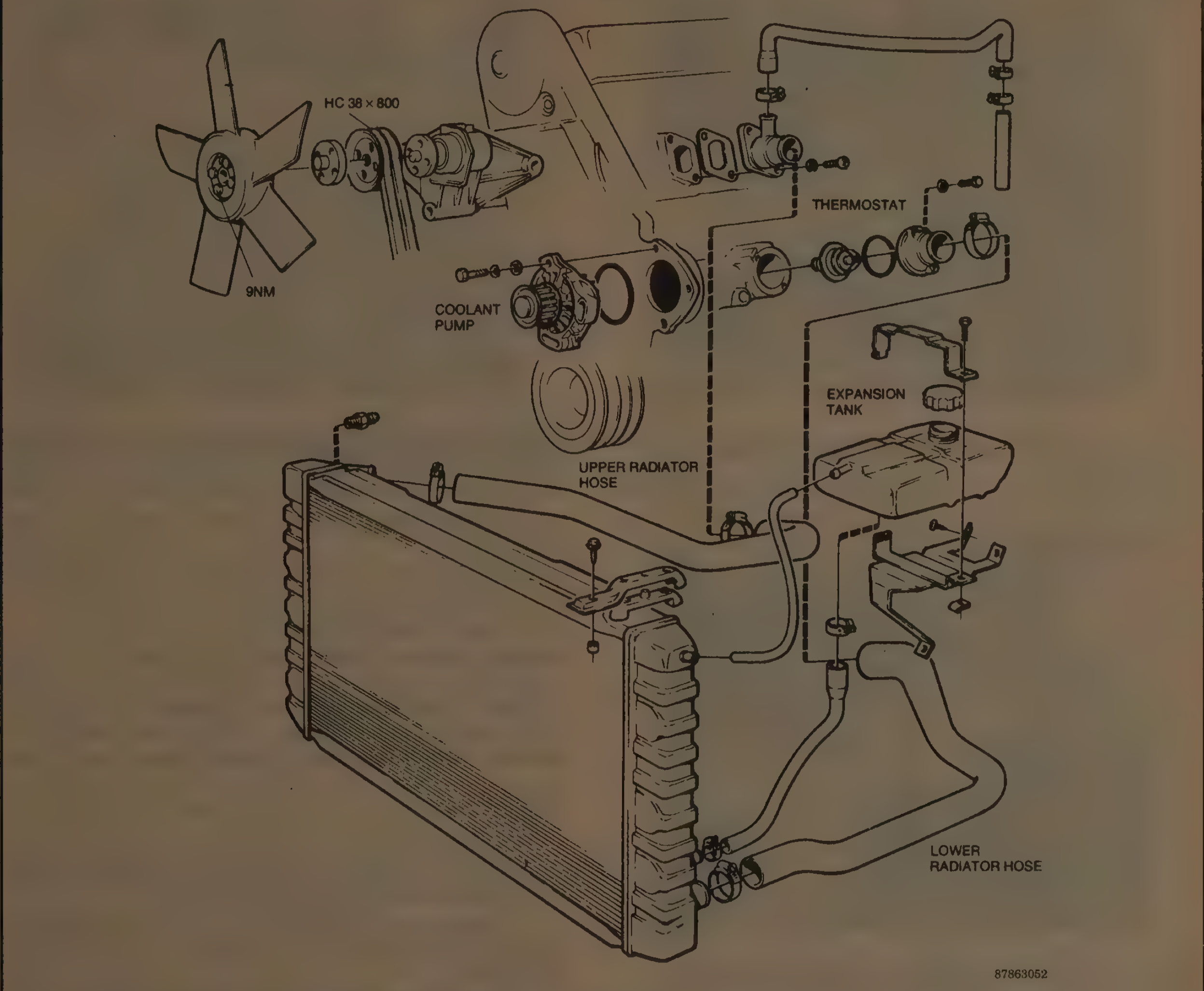

Fig. 53 Exploded view of the diesel engine cooling system components and thermostat mounting

Intake Manifold

REMOVAL & INSTALLATION

B20E, B20F and B30F Engines

1. On B30F engines, remove the air cleaner. On B20E and B20F engines, remove the inlet duct-to-air cleaner hose at the inlet duct.
2. Disconnect the battery, negative cable first.
3. Disconnect the throttle and downshift linkage. Remove and label the hoses from the manifold to the PCV valve, distributor advance, and power brake booster.
4. Disconnect the contact for the throttle valve switch, and remove the ground cable for the inlet duct. On CI engines, remove the fuel injectors.
5. Remove the bolts for the inlet duct stay. Remove the inlet duct-to-cylinder head retaining nuts and slide the inlet duct off the studs.
6. Discard the old gasket. To install, reverse the above procedure. Use a new inlet duct gasket.

B21F, B21FT, B23F, and B230F Engines

➧ See Figures 54, 55, 56 and 57

1. Disconnect the pipe between the EGR valve and the manifold.
2. Disconnect and remove the cold start injector and remove the crankcase ventilation hose.

➡It is not necessary to physically remove the cold start injector from the manifold if its fuel line and electrical connector are removed.

3. Remove the rubber pipes and electrical connection and remove the auxiliary air valve.
4. Remove the brace between the engine block and intake manifold. On B21FT engines, disconnect the turbocharger inlet hose (between the turbo unit and the intake manifold) and plug the hose with a clean rag.

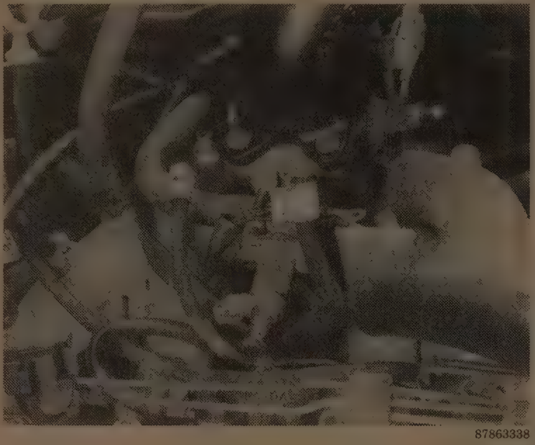

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Fig. 54 Detach and label all hoses and electrical connections

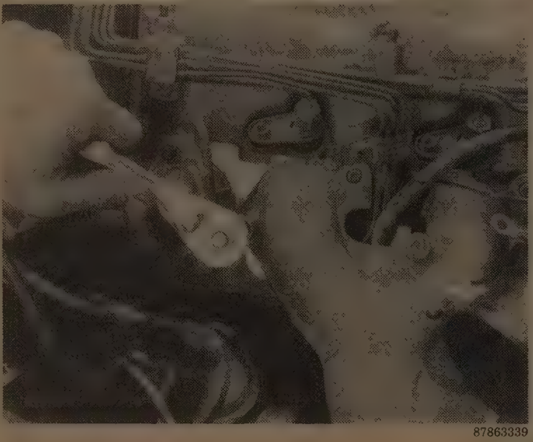

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Fig. 55 Remove the eight 13mm nuts to loosen the intake manifold for removal

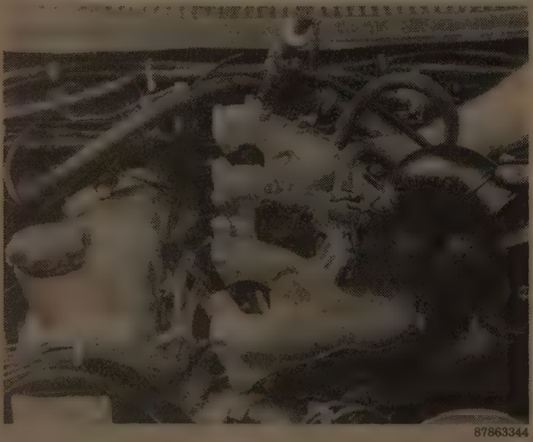

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Fig. 56 Remove the manifold and set it aside in a safe place

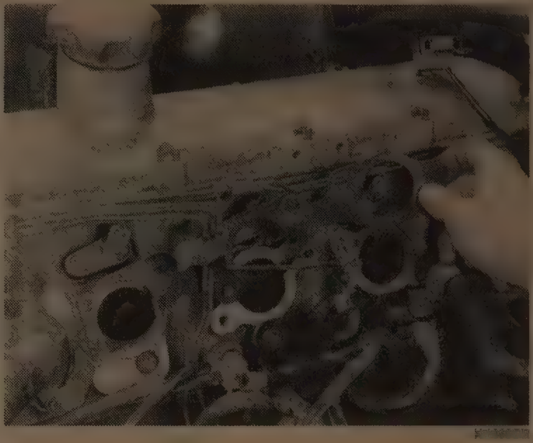

Fig. 57 Remove the old gasket and discard it — make sure the mating surfaces are clean prior to reinstallation

5. Label and disconnect the distributor vacuum hose at the intake manifold.
6. Loosen the clamp and slide off the large rubber hose at the bottom of the intake manifold.
7. Remove the eight 13mm nuts and remove the intake manifold and gasket. Reinstall with new gaskets. Remember to remove the plug from the turbo inlet hose if so equipped. Installation is the reverse of removal. Tighten the manifold-to-cylinder head nuts to 15 ft. lbs. (20 Nm). Double check all hose and wiring connections for proper placement and routing.

B234F Engines

1. Remove the air mass meter and the air intake hose.
2. Detach the throttle pulley from the intake manifold and remove the link rod from the throttle lever.
3. Separate the throttle housing from the intake manifold and cut the cable tie holding the wiring to the vacuum hose connections.
4. Disconnect the lines and hoses from the manifold, including the brake booster vacuum hose, the evaporation line, the oil trap, the fuel pressure regulator line and the air control valve line. If the car is equipped with a vacuum tank, disconnect its line at the manifold.
5. Disconnect the fuel return line at the distribution pipe. Disconnect the wiring to the injectors and remove the distribution pipe and injectors. Immediately protect these components from the entry of any dirt.
6. Unbolt and remove the intake manifold from the engine.
7. If installing a new manifold, it is necessary to transfer the various hose nipples and plugs to the new part. Install the manifold with a new gasket. Starting with the center bolts and working outward, tighten the bolts to 15 ft. lbs. (20 Nm).
8. Reconnect the hoses to their proper ports.
9. Position the injector wiring between cylinders 2 and 3 and reinstall the fuel distributor rail and the injectors. Tighten the pipe and the ground wires to the block. Connect the fuel pressure regulator line to the intake manifold.
10. Install the throttle pulley and connect the link rod.
11. Install the throttle housing with a new gasket. Check the operation of the throttle stops and switches.
12. Install the air mass meter and air inlet hose.

B27, B28 and B280 Engines

See Figures 58, 59 and 60

➡Instructions below are for the B280 family of engines. B27 and B28 are similar, but older engines may not contain all components noted below. All wires and hoses should be labled at the time of removal. The amount of time saved during reassembly makes the extra effort well worthwhile.

1. Disconnect the negative battery cable.
2. Loosen the gas cap to allow pressure within tank to equalize, then retighten the cap.
3. Remove the air intake duct. Remove the oil filler cap and hoses.
4. Disconnect the fuel lines from the filter and the fuel return pipe.

****CAUTION**

The fuel system is under pressure. Release pressure slowly and contain spillage. Observe no smoking/no open flame precautions

5. Remove the air control valve from the inlet manifold.
6. Remove the spark plug wires from the spark plugs, the ignition coil and the wire holder; position the wires out of the way.
7. Remove the injectors from the cylinder head. Plug the injector holes with paper or a rag.
8. Loosen clips and remove distributor cap. This prevents damage to the cap when removing the manifold.
9. Label and remove the vacuum hoses from the charcoal canister and the power brake booster. Also disconnect the vacuum hose at the right rear corner of the manifold and the hose to the T-connector. For ease of reinstallation, disconnect all of these hoses only at the manifold end.
10. Loosen the retaining bolts and remove the front (double horseshoe) section of the intake manifold. Plug the large holes in the manifold with crumpled paper.
11. Remove cables from the throttle control pulley. There will always be a throttle cable; there may be a kickdown cable (automatic transmission) and possibly a cruise control cable.
12. Label, disconnect, and move to one side the wiring harness(es).
13. Using a 5mm Allen wrench, loosen and remove the control pressure regulator. Lay the regulator on top of the engine.
14. Remove the four bolts holding the intake manifold. Remove the manifold carefully. Plug the intake ports in the engine immediately.

To install:

15. Remove the plugs from the intake ports on the engine. Using NEW O-rings (seals), install the manifold in place, install the four bolts and tighten to 7-11 ft. lbs. (9-15 Nm). Do not overtighten these bolts
16. Reattach the distributor cap.
17. Install the injectors.
18. Connect and fasten the spark plug wires.

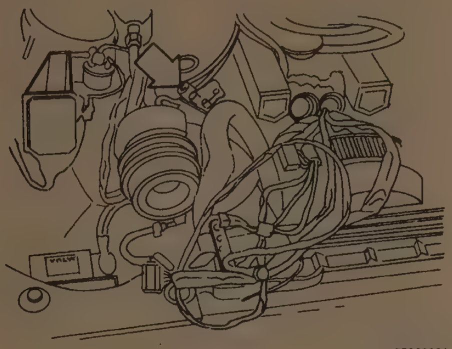

Fig. 58 Remove and set aside the control pressure regulator — B280 engine shown

19. Replace the control pressure regulator and air control valve.
20. Connect and fasten wiring harness(es).
21. Connect cables to the throttle pulley.
22. Using NEW gaskets and O-rings, install the front section of the manifold. Do not over tighten bolts. Don't forget to remove the plugs in the ends of the manifold.
23. Connect all vacuum hoses. Refer to illustration for help.
24. Reconnect the lines to the fuel filter and the fuel return. Reconnect the air intake tube and replace the oil filler cap and hoses.
25. Connect the battery cable. Start the engine and check your work. It may be necessary to adjust the throttle cable and/or idle speed.

D24 and D24T Diesel Engines

1. Remove the air cleaner to intake manifold bellows.
2. Remove the preheat hose and panels. Remove the hose and wire from the safety valve, located on the front end of the manifold. Remove the hose to the fuel limiter; this hose is located on the rear of the manifold.
3. On the D24T engine, disconnect the turbocharger inlet hose (between the turbo unit and the intake manifold) and plug the hole immediately. The hose can be pushed up into the manifold.
4. Using a 6mm Allen wrench, remove the ten attaching bolts and remove the intake manifold.
5. Installation is the reverse of removal. When installing gasket, make sure the green side faces the cylinder head and apply a light coat of lubricant to keep the gasket in place during installation. Check the O-rings for the safety valve and compressor (turbo) tube and replace the rings if needed. Tighten the manifold bolts to 18 ft. lbs. (24 Nm).

➡When installing the bellows to the intake manifold, make sure the PCV hose is positioned so that it will not make contact with the hood when the hood is closed.

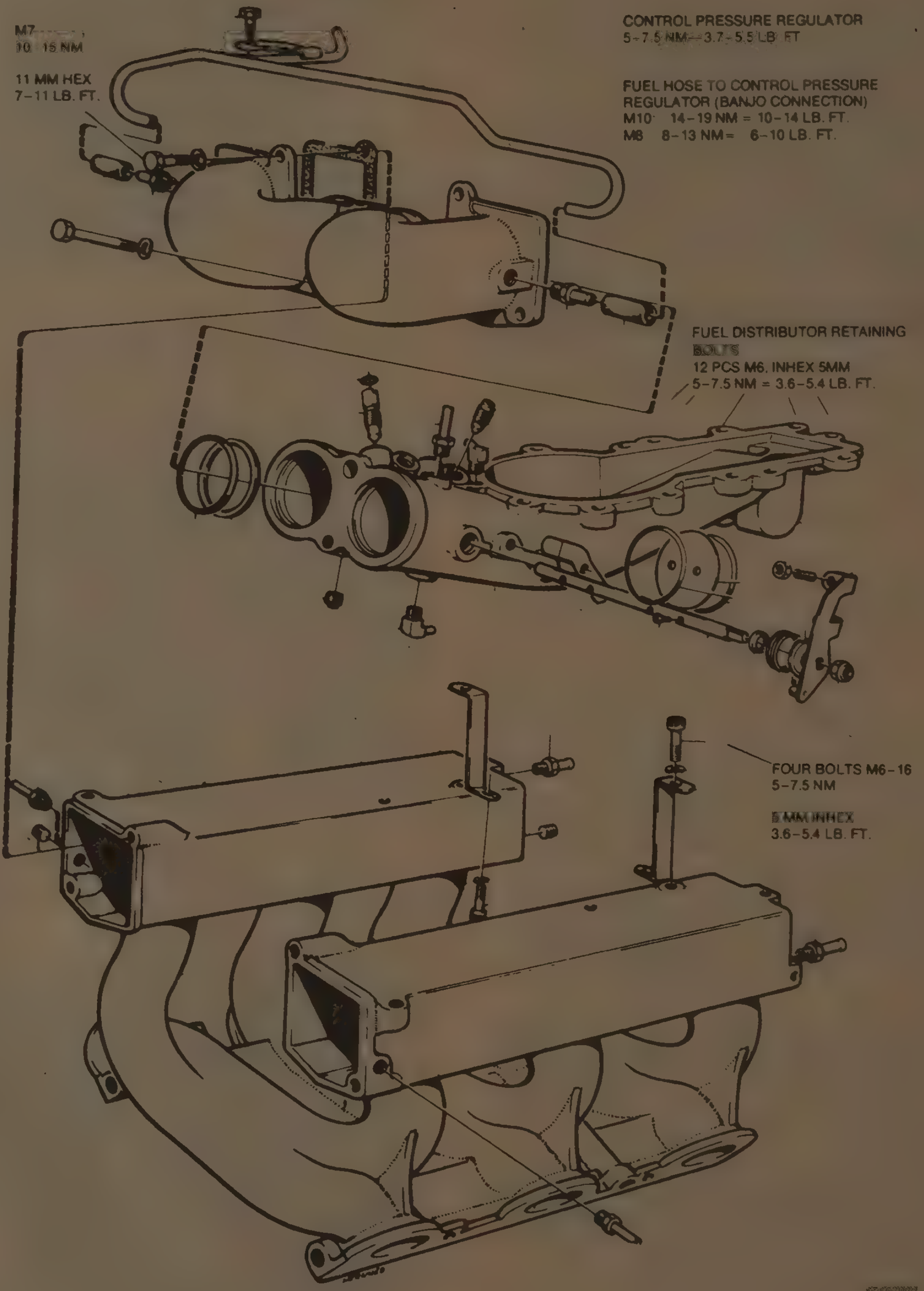
M7
10–15 NM
11 MM HEX
7–11 LB. FT.
CONTROL PRESSURE REGULATOR
5–7.5 NM = 3.7–5.5 LB. FT
FUEL HOSE TO CONTROL PRESSURE
REGULATOR (BANJO CONNECTION)
M10 14–19 NM = 10–14 LB. FT.
M8 8–13 NM = 6–10 LB. FT.
FUEL DISTRIBUTOR RETAINING
BOLTS
12 PCS M6, INHEX 5MM
5–7.5 NM = 3.6–5.4 LB. FT.
FOUR BOLTS M6–16
5–7.5 NM
5 MM INHEX
3.6–5.4 LB. FT.

Fig. 59 Exploded view of a B27F engine intake manifold — the B28F manifold is similar

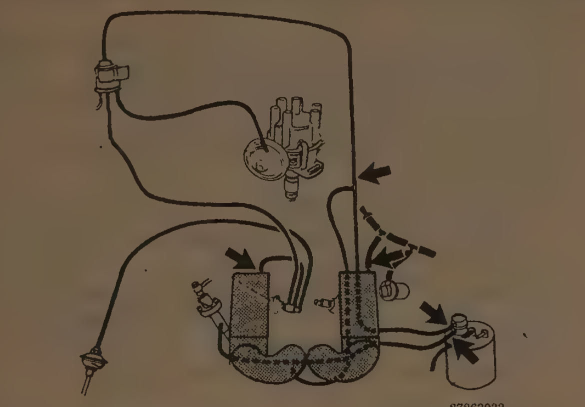

Fig. 60 Vacuum hose routing for the B280F engine intake manifold — arrows indicate points to be disconnected when removing the manifold

Exhaust Manifold

REMOVAL & INSTALLATION

➡Exhaust manifold removal and installation for most carbureted engines is contained in the Combination Manifold procedure, above.

B20 and B30 (Electric Fuel Injected) Engines

➡This procedure is for exhaust manifold gasket removal and installation only.

1. Disconnect the negative battery cable.
2. Remove the air cleaner.
3. Label and remove the throttle control, all hoses and electrical cables from the intake manifold.
4. Remove the battery. Disconnect the EGR valve from the upper pipe, then remove the lower pipe with the EGR valve.
5. Remove the nuts and lift off the intake manifold.
6. Remove the clamp holding the exhaust pipes to the gearbox.
7. Pull out the exhaust manifold from the cylinder head and remove the manifold gasket.
8. Clean the contact surfaces on the manifold and the cylinder head.
9. Fit a new gasket on the cylinder head studs.
10. Fit the exhaust manifold in position and install the retaining nuts. Tighten the nuts to 13-16 ft. lbs. (18-22 Nm).
11. Remaining installation is the reverse of removal. Use a new gasket when reinstalling the intake manifold. Remember to tighten the exhaust clamp at the transmission.

B20 (Continuous Fuel Injected) Engine

➡This procedure is for exhaust manifold gasket removal and installation only.

1. Disconnect the negative battery cable.
2. On automatic transmission models, remove the ATF filler pipe retaining screw and turn the pipe out of the way.
3. Remove the retainer above the control pressure regulator.
4. Remove the connection pipe between the air flow sensor and the intake manifold.
5. Loosen the upper bolts for the intake manifold bracket, then remove the lower bolt.
6. Remove the exhaust pipe clamp at the transmission, then remove the exhaust manifold flange nuts.
7. Remove the manifold nuts and bolts.
8. Lift out the manifold to expose the gasket. Then remove the gasket and clean the mating surfaces on the manifold and cylinder head. Install the new gasket and position the manifold on its studs; install the nuts and tighten to 6.5 ft. lbs. (9 Nm). Remaining installation is the reverse of the removal process. Remember to secure the exhaust hardware at the transmission and to tighten the retaining screw on the automatic transmission filler pipe.

B21F, B21T and B23F Engines

➧ See Figures 61, 62, 63 and 64

➡On models equipped with air pumps, the pump may have to be removed to gain access to the manifold.

1. Remove the EGR valve pipe from the rear of the exhaust manifold or from the turbo on the B21FT engine.
2. Jack up the car and support it on jackstands.
3. Remove the nuts and disconnect the exhaust pipe at the manifold flange.

➡To gain access to the bolts, you may opt to remove the shield plate bolted above the flange.

4. Remove the eight nuts and remove the exhaust manifold.

When installing new gaskets, the gasket side marked UT should face out. Install the manifold and fit the lifting eye on the top stud for cylinder No. 3. Washers stamped with the marks UT or OUT should face out or away from the engine. Tighten the manifold nuts to 10-20 ft. lbs. (14-27 Nm), and the manifold to exhaust pipe nuts to 22-30 ft. lbs. (30-41 Nm).

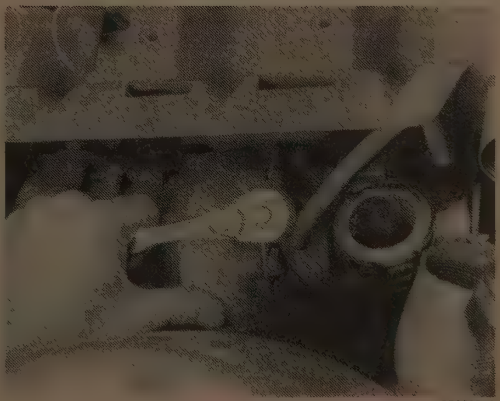

Fig. 61 Remove the EGR valve pipe from the rear of the exhaust manifold or from the turbo — as shown on this B21FT engine

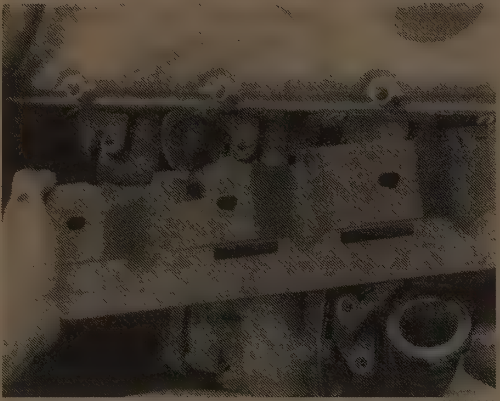

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Fig. 62 To gain access to the exhaust manifold nuts, you may opt to remove the shield plate bolted above the flange

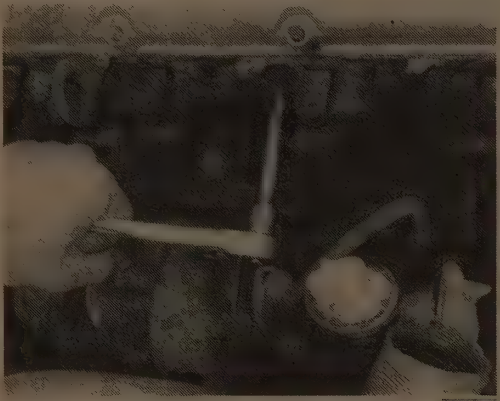

Fig. 63 Remove the eight nuts from the studs — if necessary, use a penetrating lubricant to first soak any that are rusted

Fig. 64 Remove the exhaust manifold and the old gaskets — always use new gaskets on a clean surface when reinstalling

B234F Engine

1. Disconnect the front exhaust pipe from the manifold. Disconnect the catalytic converter from the front muffler.
2. Remove the heat shields (top and bottom) from the manifold and remove the air preheat hose.
3. Disconnect the front exhaust pipe from the bracket on the bell housing.
4. Unbolt the exhaust manifold and remove it from the car.
5. Install the manifold with a new gasket and tighten the bolts to 15 ft. lbs. (20 Nm).
6. Install the front exhaust pipe with a new gasket; tighten the joint to the manifold to 20 ft. lbs. (27 Nm). Reattach the catalytic converter to the front muffler.
7. Install the heat shields and the preheat hose.

B27F and B28F Engines

Depending on the type of optional equipment your particular vehicle has, the exhaust manifolds may be removed from underneath the car.

1. Jack up the vehicle and properly support it with jacks stands.
2. Unbolt the crossover pipe from the left and right side of the exhaust manifolds, (if so equipped).

➡If your car has the Y-type exhaust pipe, disconnect this pipe at the left and right manifolds.

3. Remove any other necessary hardware and the manifold retaining nuts.
4. Remove the left and right side manifolds.
5. When reinstalling, always use new gaskets. Gaskets must be installed with the reinforced metal edge facing the cylinder head. Tighten the manifold bolts to 7-11 ft. lbs. (9-15 Nm). Remember to reconnect and secure the exhaust pipes under the car.

D24 Diesel Engine

◗ See Figure 65

1. Disconnect the negative battery terminal.
2. Remove the air cleaner and all necessary hoses.
3. Remove the exhaust pipes from the manifold.
4. Loosen and remove the manifold retaining nuts. (Access to the upper nuts will be difficult; they are located under the intake manifold flanges.)
5. Remove the manifold in two pieces.
6. When reinstalling, always use new gaskets and new nuts. Tighten the retaining nuts to 18 ft. lbs. (24 Nm).

D24T Turbocharged Diesel Engine

◗ See Figures 66 and 67

➡This procedure requires removal of the turbocharger. While no special tools are required, the turbocharger must be handled carefully and kept completely free of dirt and fluid contamination.

1. Disconnect the negative battery cable, the inlet hose to the turbocharger, the air filter and the pre-heat hose.
2. Disconnect the hoses to the compressor inlet and the safety valve. Plug the ends of these hoses.

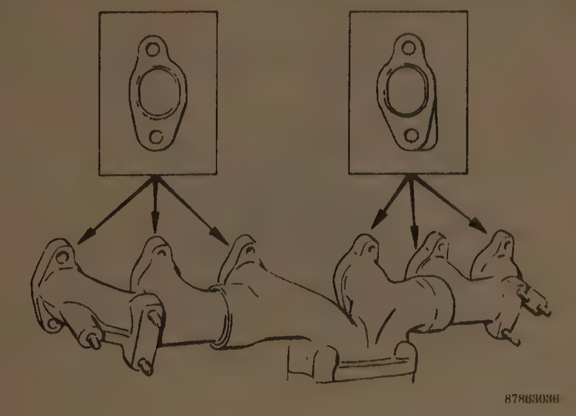

Fig. 65 Place the gaskets in the correct position as shown on the exhaust manifold

3. Loosen and remove the exhaust pipe from the turbocharger and disconnect the exhaust system from the transmission crossmember.
4. Detach oil delivery and return lines from the turbocharger and plug the line ends.
5. Remove the pre-heating panels.
6. Push or slide the compressor tube into the intake manifold. Loosen and remove the twelve manifold retaining nuts and gently pull the manifold away from the engine. Remove the gaskets from the cylinder head.
7. Detach the turbocharger from the branch pipe and carefully remove the manifold and turbocharger from the car.
8. The turbocharger may be separated from the manifold on the workbench; plug all ports on the turbocharger with rags and keep the unit as clean as possible. Do not drop or jar the turbo unit.
9. The exhaust manifold may be separated into three (older cars, two) sections. If the same manifold unit is to be reinstalled on the engine, DO NOT separate the sections.

If the sections must be separated, do so by tapping with a plastic mallet. After needed repairs have been performed, reassemble by removing all traces of soot and lubricating the contact faces. Place the flanges on a level surface and tap the pieces together. Don't forget to install the spacers.

Since the bolt holes must fit over the studs on the head, correct separation must be maintained between the holes. When re-assembling the manifold, maintain 3.54 in (90mm) between the center of the bolt holes.

Check spacing with trial fittings onto the head; adjust the manifold sections as necessary to get the proper fit.

10. Using a light coat of sealer and new nuts, attach the turbocharger to the exhaust manifold. Tighten the nuts to 43 ft. lbs. (58 Nm). Remember to remove plugs from the ports in the turbocharger.
11. Place new exhaust gaskets on the cylinder head. The raised section of the gasket should face out or towards the exhaust manifold.
12. Install the manifold with the turbocharger attached. Use new nuts and tighten to 18 ft. lbs. (24 Nm).
13. Pull or slide the compressor tube down from the intake manifold. Check the seals and O-rings for condition and replace if necessary. Attach the tube to the turbocharger.
14. Remove the plugs and connect the oil delivery and oil return lines to the turbocharger. Use new gaskets.
15. Install the pre-heating panels. Using new gaskets, connect the exhaust pipe to the turbocharger. Volvo recommends the use of an anti-rusting compound on the threads. Re-attach the exhaust fittings and brackets at the transmission and crossmember.
16. Reconnect the hose from the safety valve to the turbo inlet. Attach the PCV hose and attach the air filter unit. reinstall the air inlet hose and the pre-heat hose.
17. Reconnect the negative battery cable. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

Turbocharger

REMOVAL & INSTALLATION

B21FT and B23FT Engines

➧ See Figures 68, 69, 70, 71 and 72

➡Due to the complexity and close tolerances involved with the turbocharger unit, we recommend that any service other than removal and installation be performed by an experienced turbo technician. It should also be mentioned that the turbocharger unit has other controls mounted on it. These devices control various pressures developed by the turbocharger. DO NOT attempt to alter or adjust the linkages or settings; severe and immediate damage to the engine may occur if the turbo air flow is altered.

1. Disconnect the negative battery cable.
2. Disconnect the expansion tank and its retainer.
3. Remove preheater hose to the air cleaner. Remove the pipe and rubber bellows between the air/fuel control unit and

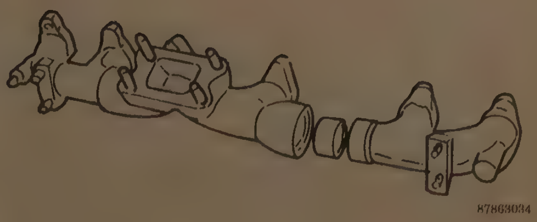

Fig. 66 Two-piece and three-piece exhaust manifolds as found on turbo-diesel engines

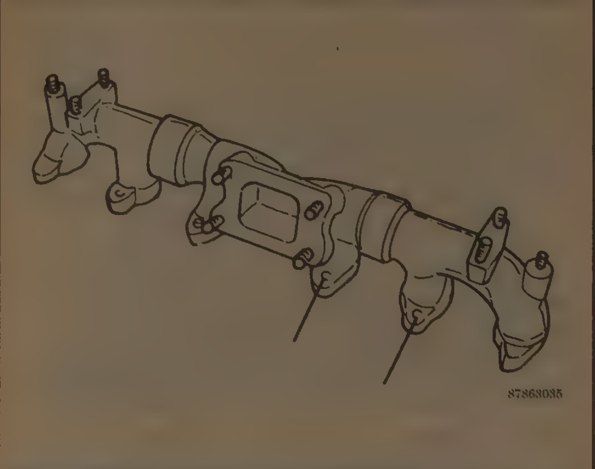

Fig. 67 Maintain correct hole spacing when reassembling turbo-diesel manifolds

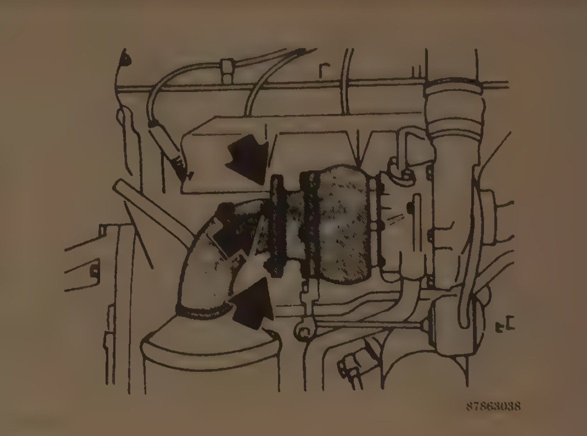

Fig. 69 Disconnect the turbocharger from the exhaust system on the flange indicated by the arrows

the turbocharger unit. Pull out the crankcase ventilation hose from the pipe.

4. Remove the pipe and pipe connector between the turbocharger unit and the intake. Cover the turbocharger intake and outlet ports to keep dirt out of the system.
5. Disconnect the exhaust pipe and secure it out of the way.
6. Disconnect the spark plug wires at the plugs.
7. Remove the upper heat shield. Remove the brace between the turbocharger unit and the manifold.
8. Remove the lower heat shield by removing the one retaining screw underneath the manifold.
9. Remove the oil pipe clamp, the retaining screws on the turbo unit and the pipe connection screw in the cylinder block under the manifold. DO NOT allow any dirt to enter the oilways.
10. Remove the manifold retaining screws and washers. Let one nut remain in place to keep the manifold in position.
11. Remove the oil delivery pipe. Cover the opening on the turbo unit.

Fig. 70 Unbolt the exhaust system-to-turbo flange (it is recommended that the intake bellows and pipe be removed first)

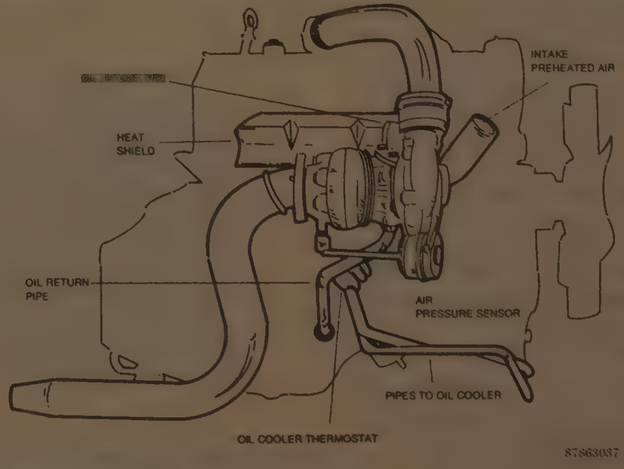
OIL INTAKE PIPE
INTAKE PREHEATED AIR
HEAT SHIELD
OIL RETURN PIPE
AIR PRESSURE SENSOR
PIPES TO OIL COOLER
OIL COOLER THERMOSTAT
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Fig. 68 Component location for the common turbocharger system

12. Disconnect the air/fuel control unit by loosening the clamps. Move the unit with the lower section of the air cleaner up to the right side wheel housing. Place a cover over the wheel housing as protection.

13. Remove the air filter.

14. Remove the remaining nut and washer on the manifold. Lift the assembly forward and up. Remove the manifold gaskets. Disconnect the return oil pipe O-ring from the cylinder block.

15. Disconnect the turbocharger unit from the manifold.

16. When reinstalling, be sure to use a new gasket for the exhaust manifold and a new O-ring to the return oil pipe. Keep everything clean during assembly, and use extreme care in keeping dirt out of the various turbo inlet and outlet pipes and hoses. Remember to remove the plugs from various ports and lines before reassembly.

17. Assemble the turbocharger to the exhaust manifold. Tighten the four bolts in the sequence shown. Use a three step tightening procedure:

Step 1: 7 ft. lbs. (10 Nm)
Step 2: 30 ft. lbs. (41 Nm)
Step 3: Tighten the bolts an additional 120°

18. Install the turbo and manifold assembly onto the engine. The designation UT or the word OUT on the new gaskets should face away from the engine.

19. Lightly grease a new O-ring and install it on the oil return pipe. Lift the pipe into position by guiding it through the hole in the cylinder block. Make sure the O-ring seats properly.

20. Install one washer and nut to hold the manifold and turbocharger in place.

21. Install the air/fuel control unit and the air filter.

22. Fill the turbocharger oil inlet port with oil. This will prelube the compressor when the engine is first started.

23. Install the oil delivery pipe and make the connection finger-tight. Make sure no dirt enters the pipe or clings to fittings.

24. Install manifold washers and nuts. Don't forget to install the lifting eye (hook). Tighten the manifold retaining bolts to 18 ft. lbs. (24 Nm). Using new seals, connect the oil delivery pipe to the turbocharger. Install the pipe-clamp for the oil delivery pipe and tighten connection(s) for this pipe.

25. Install the upper and lower heat shields, install the brace between the manifold and the turbocharger, and reconnect the spark plug wiring.

26. Connect the exhaust pipe.

27. Attach the pipe and rubber bellows between the air/fuel control unit and the turbocharger. Reconnect the PCV hose and the pre-heat hose to the air cleaner. Install the intake pipe between the turbocharger and the intake manifold. Double check all hoses for proper positioning and tightened clamps.

28. Replace the expansion tank and its retainer. Connect the negative battery cable.

29. IMPORTANT: Disconnect the wire (usually brown) at terminal No. 15 of the ignition coil. Use the ignition key to run the starter for about 30 seconds; the engine will turn but will not start. This circulates the oil within the turbocharger, insuring proper lubrication when the engine is started. With the ignition key off, reconnect the wire to terminal 15 on the coil.

30. Start the engine and allow it to idle for at least 30 seconds before increasing engine speed.

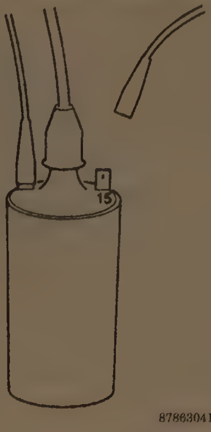

Fig. 72 To prelube the turbocharger by cranking the engine, FIRST disconnect terminal No. 15 on the coil

D24T Engine

1. Remove the negative battery cable.
2. Remove the inlet hose from the turbo pipe.
3. Remove the complete air cleaner assembly, and the preheater hoses.
4. Remove the snapring from the turbocharger intake pipe, and remove the compressor intake pipe. Plug the hose immediately.
5. Disconnect the bolts securing the oil return pipe to the turbo unit. Move the pipe aside, and plug the holes immediately.
6. Remove the oil delivery pipe from the turbocharger and plug the holes.
7. Press or slide the compressor pipe into the intake manifold. Remove the exhaust pipe from the turbocharger.
8. Jack up the car, and place stands safely underneath. Remove the exhaust pipe from the transmission support bracket and disassemble the joint. Remove the exhaust pipe.
9. Remove the turbocharger securing nuts, and lower the front end of the turbo unit. Remove the turbocharger and then remove the compressor pipe.

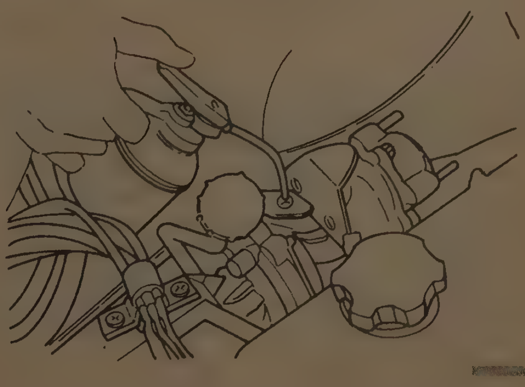

Fig. 71 On gasoline engines, fill the turbocharger oil inlet port with oil when reassembling

10. If the turbocharger is replaced complete, transfer the necessary parts to the new unit. Always use new gaskets.

11. During installation, make sure all hoses are connected without the addition of any dirt into the system. This is crucial to the life of the turbocharger and the engine. Mount the turbocharger onto the manifold. Use new nuts (no gasket is required) and tighten the nuts to 44 ft. lbs. (60 Nm). Slide the compressor intake pipe down onto the turbocharger.

12. Remember to remove all plugs and line covers. Attach the oil delivery pipe, the oil return pipe (with a new seal) and the exhaust pipe with a new gasket.

13. Under the car, attach the exhaust pipes and secure the brackets at the transmission.

14. Install the turbocharger intake pipe. Apply oil to the inside of the tube and to the O-ring; install it on the outer groove of the turbocharger.

15. Reconnect the hose for the safety valve.

16. Reinstall the air cleaner with the intake and pre-heat hoses. Connect the negative battery cable.

Air Conditioning Compressor

➧ See Figure 73

Removing the air conditioning compressor is generally a straightforward task. It may be necessary to remove the compressor for unit repair or for access to other parts of the motor. Removing the compressor from the car requires discharging and recharging the system. It is possible to remove the compressor from its mounts and reposition it out of the way WITHOUT discharging the system or removing the refrigerant hoses.

➡R-12 refrigerant is a chlorofluorocarbon which, when released into the atmosphere, contributes to the depletion of the ozone layer. Ozone filters out harmful radiation from the sun. Consult the laws in your area before servicing the air conditioning system. In some states it is illegal to perform repairs involving refrigerant unless the work is done by a certified technician. It is also likely that you will not be able to purchase R-12 without proof that you are properly trained and certified to work on A/C systems.

The first three steps of removal are always the same, regardless of type of compressor or system:

1. Disconnect the negative battery cable.

2. Discharge the system safely, in accordance with the instructions in Section 1.

3. Remove or reposition any components blocking access to the compressor belt and bolts. Depending on your vehicle, it may be necessary to remove the air intake duct, the power steering pump (Don't disconnect the hoses--just move the pump!) and/or an assortment of vacuum hoses and wires. Where possible, relocate hoses and wires without disconnecting either end. On earlier cars it may be necessary to gently tie the upper radiator hose out of the way; this can be done without draining the coolant system.

4. Carefully loosen and disconnect the refrigerant lines from the compressor. Immediately cap the lines and compressor ports with tape to prevent entry of dirt and moisture.

5. Loosen the compressor bolts; move it to loosen the belt and then remove the belt. On the B21, B23 and B230 family of engine, the belt cannot be removed in this fashion. On these engines it is necessary to remove the six bolts holding the crankshaft pulley together. As the pulley comes apart, note the number and placement of the shims between the pulley halves. These shims determine the belt adjustment; it is important that the same number be put back in the same location during reassembly.

6. Disconnect the wiring to the compressor.

7. Remove the compressor mounting bolts and remove the compressor. Most compressors are heavier than they appear; support the compressor securely when removing. Keep the compressor in an upright position on the workbench--do not allow oil to run out!

8. During reassembly, tighten the refrigerant lines to 20 ft. lbs. (27 Nm) and make certain that any small washers or O-rings are in place and properly seated. Remember to remove plugs and tape form lines and ports before installing.

9. On B21, B23 and B230 engines, the shims within the crank pulley determine belt adjustment. Add or subtract shims as necessary to get the correct belt tension. On all other models, install the belt and draw the correct tension by moving the compressor to the proper position and tightening the mounting bolts.

10. Attach and secure any components, wires or hoses moved to gain access.

11. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

12. Refer to Air Conditioning section in Section 1 for detailed instructions on recharging the air conditioning system.

Air Conditioning Condenser

REMOVAL & INSTALLATION

➧ See Figures 74 and 75

The air conditioning condenser operates under the pressures generated within the air conditioning system. Its removal re-

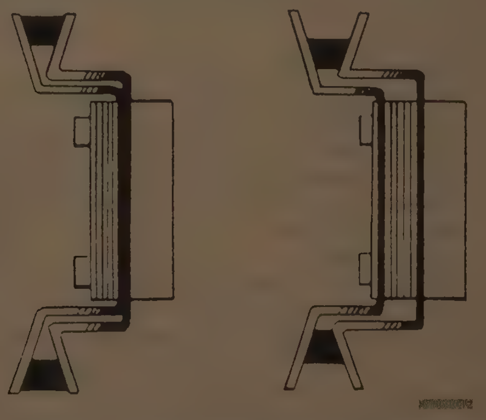

Fig. 73 Add or remove shims to alter A/C compressor belt tension. Cross-sectional view demonstrates the principle — B21, B23 and B230 engines

quires discharging the system and recharging after reinstallation.

The condenser is a frequent source of leaks within AC systems. Because of its position at the very front of the car, it is prone to impact damage from stones and road hazards, as well as cracks and loosened hoses from vibration.

➡R-12 refrigerant is a chlorofluorocarbon which, when released into the atmosphere, contributes to the depletion of the ozone layer. Ozone filters out harmful radiation from the sun. Consult the laws in your area before servicing the air conditioning system. In some states it is illegal to perform repairs involving refrigerant unless the work is done by a certified technician. It is also likely that you will not be able to purchase R-12 without proof that you are properly trained and certified to work on A/C systems.

1. Remove the negative battery cable. Carefully remove the grille from the front of the car.
2. Remove the support brace in front of the condenser. Disconnect the hood release cable.
3. Loosen and remove the bolts holding the upper radiator support. Remove the air guide panel from the upper radiator support, remove the screws which hold the condenser to the upper support, and remove the upper radiator support itself.
4. Under the front bumper, remove the three screws holding the plastic air guide and remove the guide. If the car is equipped with an electric fan, unbolt it as a unit and set it aside.
5. Discharge the refrigerant from the system in accordance with the instructions in Section 1.
6. Using TWO wrenches of the proper size, disconnect the pipes at the joints nearest to the condenser. Use one wrench to hold one line and the other wrench to turn the opposite fitting. Failure to do this may result in kinked or broken lines. Plug the lines immediately to prevent dirt from entering the system.
7. Remove the nuts at the bottom of the condenser and remove the condenser from the car. Use a small jar to collect the oil which will run out of the condenser. The same amount of oil should be added back into the system when the unit is reinstalled.
8. When reinstalling, transfer the foam and rubber seals to the new condenser if one is being used. Add compressor oil into condenser to equal amount which drained out.
9. Position condenser in car and insure that there is a tight fit between the foam seals and the surrounding body work. This directs the airflow through the unit instead of around it.
10. Using the two wrench method, reconnect the pipes at the joints. Use new O-rings lightly coated with compressor oil. Tighten the joints to a maximum of 13 ft. lbs. (18 Nm). Replace the bolts at the bottom of the condenser.
11. Reinstall the upper radiator support, the condenser support brace and the upper and lower air guide panels. If the car is equipped with an electric fan, reinstall it.
12. Connect the hood release cable and replace the grille. Hook up the negative battery cable.

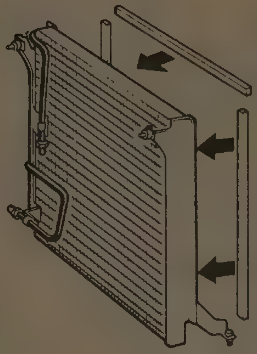

Fig. 74 Don't forget to transfer the air seals when installing the A/C condenser

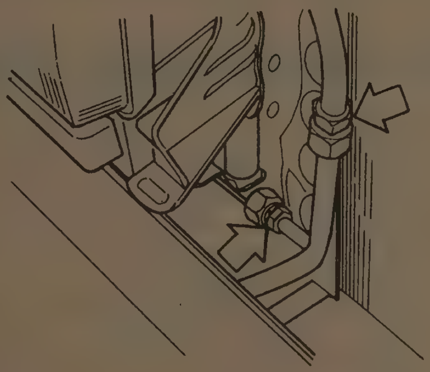

Fig. 75 Use two wrenches on A/C line joints. When reassembling, do not overtighten

13. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.
14. Recharge the air conditioning system as described in Section 1.

Radiator

REMOVAL & INSTALLATION

See Figures 76, 77, 78, 79, 80, 81 and 82

➡Perform this work only on a cold engine.

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Fig. 76 Disconnect the line from the radiator as you remove the expansion tank

1. Remove the radiator and expansion tank caps, disconnect the lower radiator hose at the radiator, and drain the cooling system.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Remove the expansion tank and hose, and drain the coolant. Remove the upper radiator hose. On cars with automatic transmissions, disconnect the transmission oil cooler lines at the radiator. Plug the lines immediately. Catch the spillage from the radiator in a separate pan.
3. On later cars equipped with electric fans, carefully disconnect the wiring to the temperature sensor at the bottom of

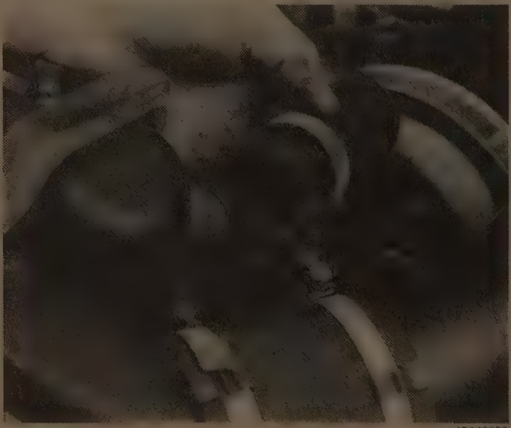

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Fig. 77 Disconnect the upper (shown) radiator hose and the lower hose

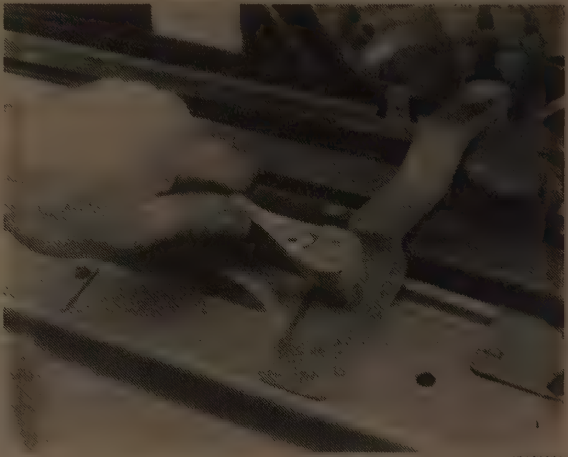

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Fig. 78 Unbolt the bracket from the radiator support

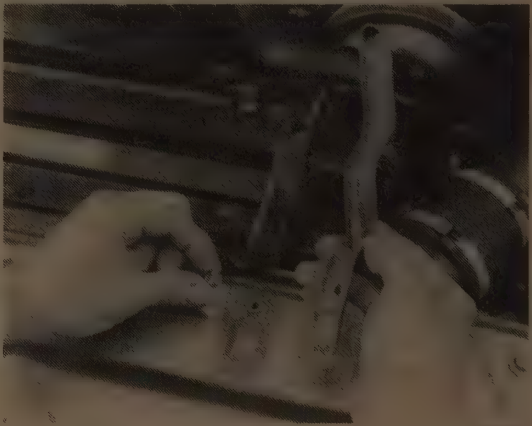

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Fig. 79 Be careful not to lose any small specialized hardware as you work towards the removal

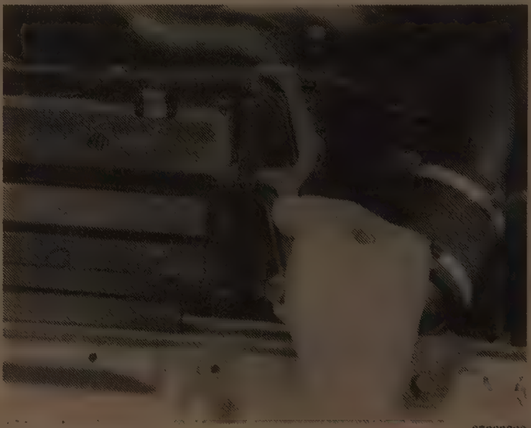

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Fig. 80 Remove the top separator piece and set it aside in order with the other hardware

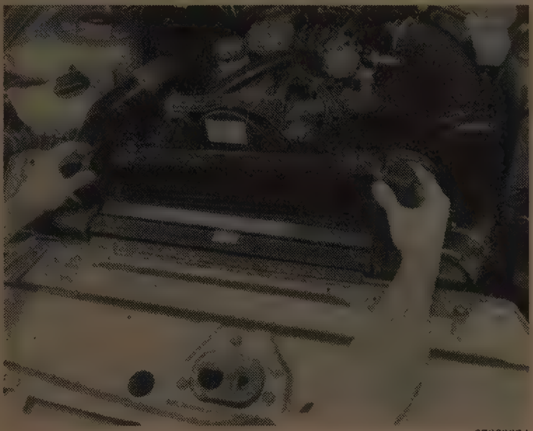

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Fig. 81 **When all points are detached, lift up and remove the radiator from the vehicle**

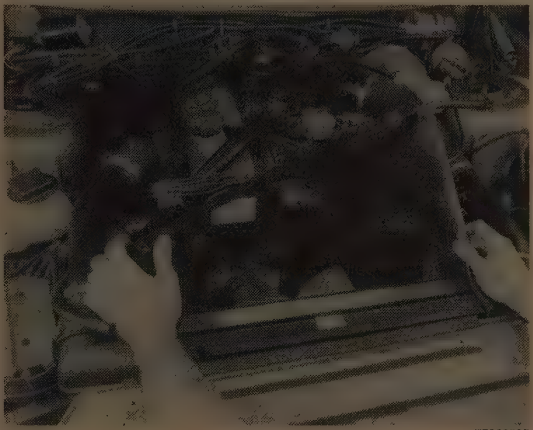

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Fig. 82 **Remove the fan shroud after the radiator has been removed**

the radiator. Remove the retaining bolts for the radiator and fan shroud and lift out the radiator.

To install:

4. Place the radiator and fan shroud in position and install the retaining bolts. Note that the placement of the radiator is important to its proper operation. The radiator must lie flush with the front bodywork, otherwise some air will go around the radiator instead of through it. Either adjust the position of the front panel or use plastic foam to seal the gaps between the radiator and the front panel.
5. On automatic transmission cars, connect the oil cooler lines.
6. Install the lower and upper radiator hoses.
7. Install the expansion tank with its hose. Make sure that the overflow hose is clear of the fan and is free of any sharp bends.
8. Fill the cooling system with a 50 percent antifreeze, 50 percent water solution. Replace the caps.
9. Start the engine and check for leaks. After the engine has reached operating temperature, make sure the coolant level in the expansion tank is between the maximum and minimum marks. Check and top up the automatic transmission fluid level.

Water Pump

REMOVAL & INSTALLATION

B20 and B30 Engines

1. Disconnect the negative battery cable.
2. Drain the cooling system and remove the radiator.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Loosen the fan belt by slackening the alternator adjusting bolt. Remove the fan belt; remove the fan.
4. Remove the housing bolts from the water pump. Carefully remove the aluminum housing from the engine along with all the old gasket material. Remove the sealing rings.

To install:

5. Position the water pump assembly to the block, using a new housing gasket and water resistant sealer. Make sure that the sealing rings on the upper side of the pump are seated fully. Press the pump upward against the cylinder head extension to seat the seals. Hand-tighten the housing bolts until snug. Do not tighten the bolts more than $1/2$ turn further to avoid cracking the housing or breaking the bolts.
6. Install the fan and adjust the (drive) belt tension.
7. Install the radiator as previously described. Fill the cooling system.
8. Attach the negative battery cable. Start the engine and check for leaks.

B21, B23 and B230 Engines

See Figures 83, 84, 85, 86, 87, 88, 89 and 90

1. Disconnect the negative battery cable. Remove the overflow tank cap. Drain the cooling system by opening the cylinder block drain cock (beneath the exhaust manifold) and disconnecting the lower radiator hose.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Remove the fan and fan shroud.

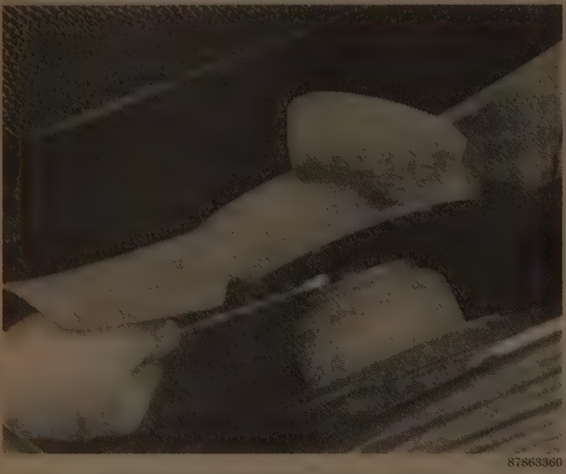

Fig. 83 Remove the nuts that retain the fan to the hub

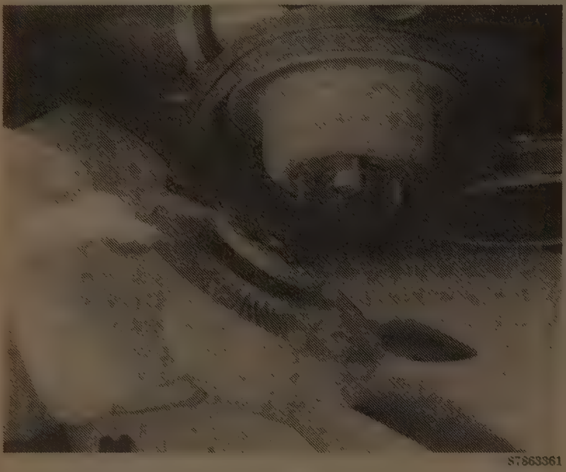

Fig. 84 When free, remove the fan to a safe location

3. Remove the alternator and air pump drive belts. Remove the water pump pulley.
4. Remove the timing belt cover.
5. Remove the lower radiator hose.
6. Remove the retaining bolts for the coolant pipe (beneath exhaust manifold) and pull the pipe towards the rear of the car.
7. Remove the retaining bolts and lift off the water pump.
8. Clean the gasket contact surfaces thoroughly. When reassembling, the use of new gaskets and O-rings is required.
9. When reinstalling pump, make certain that it seats firmly in position and that all gaskets and seals are properly located.
10. After the pump is securely mounted, replace and secure the lower pipe and bracket, the radiator hoses and the timing belt cover.
11. Attach the water pump pulley and all the drive belts. Adjust the belts to the proper tension.
12. Install the fan and fan shroud. Close the drain cock on the side of the engine and replace the expansion tank cap. Fill

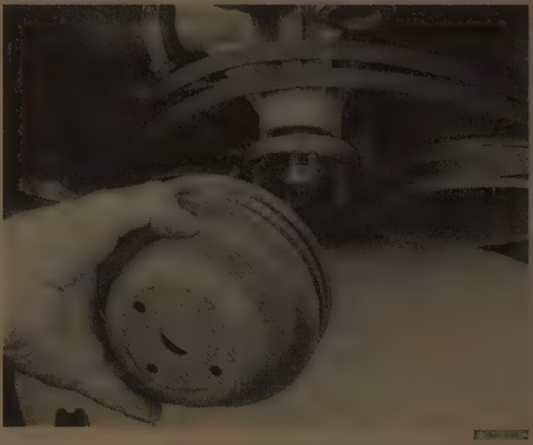

Fig. 85 Having already loosened the drive belt, remove the pulley wheel from the water pump

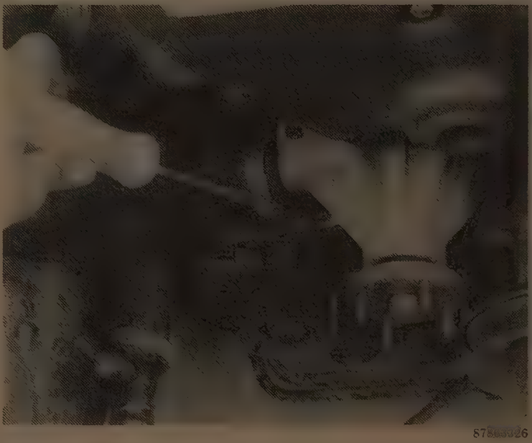

Fig. 86 Remove the hose clamp and pull off the lower radiator hose

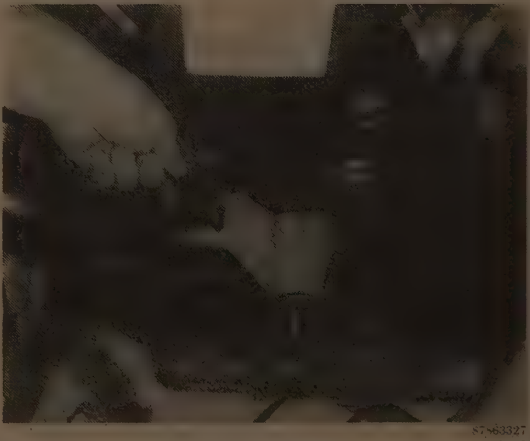

Fig. 87 Remove all the bolts holding the water pump to the housing

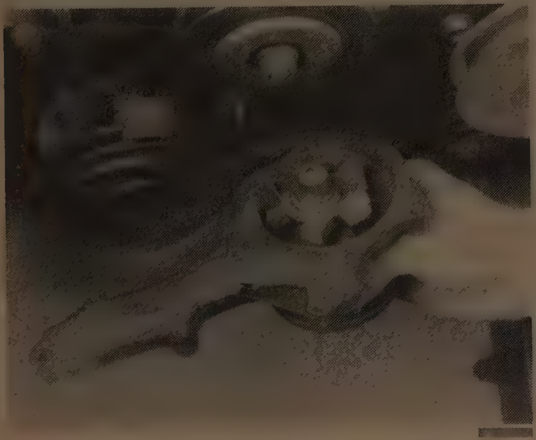

Fig. 88 Remove the water pump and set aside — all gasket surfaces must be clean before installation

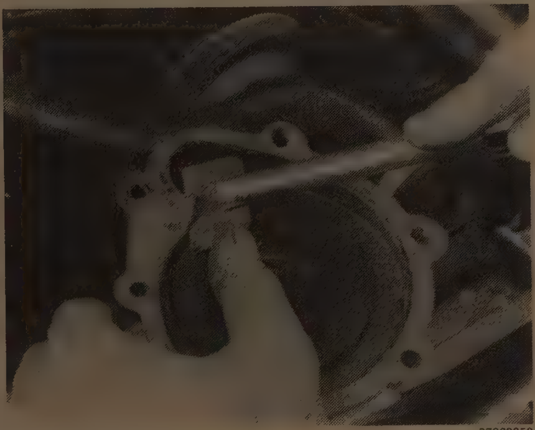
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Fig. 89 Scrape all gasket material without gouging the aluminum surfaces

the cooling system with a 50-50 mixture of antifreeze and water.

13. Reconnect the negative battery cable. Start the engine and check for leaks. After the engine has reached normal operating temperature, check the expansion tank for the proper coolant level; add fluid if necessary.

B234 Engine

1. Set the heater control for maximum heat, remove the cap on the expansion tank and open the draincock on the right side of the engine block.

✻✻CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

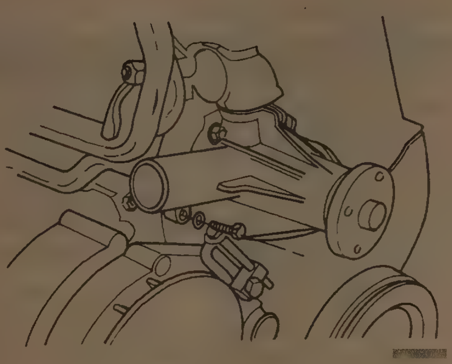

Fig. 90 Position the water pump as shown — B21, B23 and B230 engines

2. Disconnect the bottom radiator hose from the pump. Close the draincock when the system is empty.
3. Remove the alternator drive belt, the radiator fan and pulley.
4. Remove the retaining bolts and nuts and remove the water pump from the engine.
5. Clean the joint faces and mating surfaces.
6. During reassembly, use new gaskets and seals. Place the O-ring on the return tube and the gasket on the block. Make sure the ring is seated in the groove. Fit the pump into position and install the two nuts just tight enough to hold the pump against the block.
7. Press the pump vertically against the cylinder head and install the remaining bolts and washers. Reconnect the return pipe.
8. Install the bottom radiator hose, the radiator fan and pulley and the alternator drive belt.
9. Fill the system with coolant, cap the expansion tank and run the engine to normal operating temperature to check for leaks.

B27F and B28F Engines

➧ **See Figure 91**

1. Disconnect the negative battery cable.
2. Remove the front and main sections of the intake manifold.

3. Remove the overflow tank cap and drain the cooling system by opening the drain cock on the side of the block and disconnecting the lower radiator hose.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Disconnect both radiator hoses. On automatic transmission cars, disconnect the transmission cooler lines at the radiator. Remove the radiator and fan shroud.
5. Remove the fan.
6. Remove the hoses from the water pump to each cylinder head.
7. Remove the fan belts. Remove the water pump pulley.
8. Loosen the hose clamps at the rear of the water pump.
9. Carefully remove and transfer the thermal time sender and temperature sensor to the new pump.
10. Remove the water pump from the block (three bolts).
11. Transfer the thermostat cover, thermostat, and rear pump cover to the new pump. Clean all mating surfaces and remove any trace of old gasket material. Check all coolant hoses and replace them if stiff or cracked.
12. Using new gaskets, install the water pump onto the block. Do not overtighten the bolts. Correct torque is 11-15 ft. lbs. (15-20 Nm).
13. Connect and secure all hoses to the water pump.
14. Position the drive belts and install the pulley and cooling fan. Adjust all belts to the correct tension. Reconnect wiring to the electrical components on the water pump.
15. Reinstall the intake manifold. See Intake Manifold, Removal and Installation elsewhere in this section.
16. Install the radiator and fan shroud. Connect the radiator hoses to the radiator. On cars with automatic transmissions, reconnect the oil cooler lines to the radiator. If the car has electric fans, remember to connect the wiring to the temperature sensor in the radiator.
17. Put the cap on the expansion tank and close the drain cock in the side of the engine. Reconnect the negative battery cable.
18. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.
19. Refill the cooling system with a 50-50 mixture of antifreeze and water.
20. Start the engine and check for leaks. Allow the engine to reach normal operating temperature and check the coolant level; add fluid if needed. Inspect and top-up the fluid level in the automatic transmission if so equipped.

B280 Engine

➧ See Figures 92 and 93

The B280 engine, introduced in 1987, is a variant of the B28. The steps to replace the water pump are essentially the same as the B28, but the intake manifold DOES NOT need to be removed. The spark plug wires and various small hoses and brackets need removal for access, but the steps above (B28) will guide you through. Simply omit the steps for removal and installation of the intake manifold.

D24 and D24T Diesel Engines

➧ See Figures 94, 95 and 96

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure. This procedure requires the removal of the timing belt. If the special tools needed are not available, do not attempt to remove the water pump.

1. Disconnect the negative battery cable.

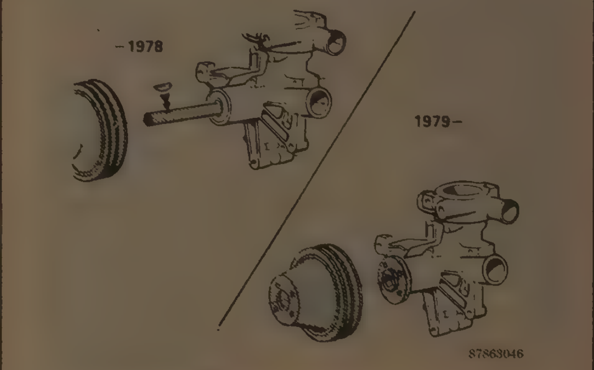

Fig. 91 Different styles of water pump pulleys for B27 and B28 — make sure to match up any replacement part(s) with the original(s)

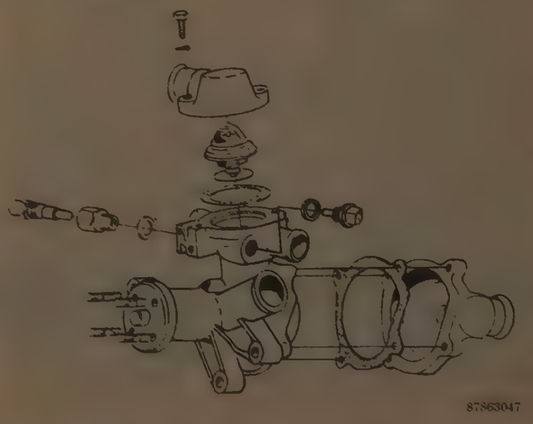

Fig. 92 Exploded view of the water pump assembly — B28F engines

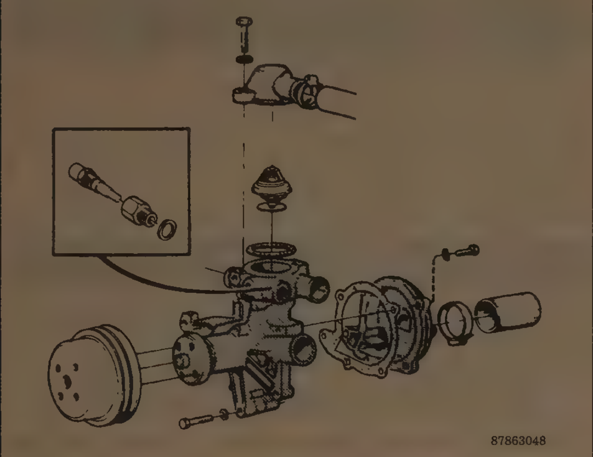

Fig. 93 Exploded view of the water pump assembly — B280 engine

2. Drain the coolant system by disconnecting the lower radiator hose at the radiator and disconnect the lower hose of the cold start device.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Remove the radiator. Remove the cooling fan with its spacer and pulley.
4. Remove the fan belt(s) and the power steering drive belt.
5. Remove the timing gear cover. When this cover is removed, the timing belt will be exposed. Do not allow fluids, dirt or oil to contact the belt. It must be kept clean and dry or premature wear and breakage may result.
6. Remove the large center bolt in the center of the vibration damper (pulley) and the crankshaft. Do not allow the pulley to turn while removing the nut. Volvo has two special tools available to accomplish this.
7. When the nut is removed, turn the pulley (and therefore, the engine) about ¼ turn counter clockwise. This transfers the slack in the timing belt to the opposite side, making it easier to remove.
8. Using a 6mm Allen wrench, remove the four small bolts holding the crank damper and remove the damper. Note that the crankshaft gear may stick to the damper. When the damper is off, remove the lower timing gear cover.
9. Loosen and remove the three bolts holding the bracket for the alternator and cooling fan. Place the assembly to one side and secure it out of the way.
10. Mark the position of the timing belt relative to the timing gears. Mark the belt, camshaft gear and crankshaft gear. Identify the outside and topside of the belt. It is critical that the belt be reinstalled in exactly the same position as it was found.

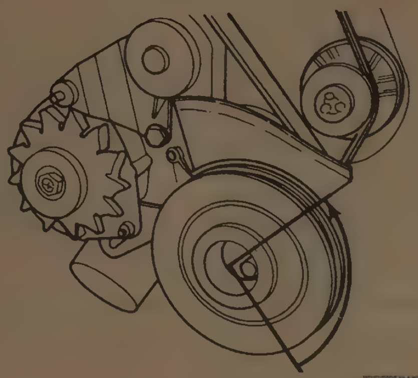

Fig. 94 Turn the engine clockwise ¼ turn to transfer the slack in the timing belt

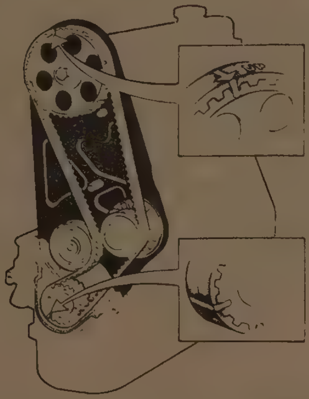

Fig. 95 Carefully mark the timing belt and gears before removing the belt. Exact reinstallation is critical to prevent motor damage

11. Loosen the water pump mounting bolts and and the timing belt. Some coolant may leak out when the bolts are loosened. Remove the timing belt.
12. Remove the cover panel and bolts holding the water pump. Move the panel to one side and remove the pump. Be careful not to crack the panel.
13. Dry off spilt coolant from the block, gears, etc. Clean the contact surfaces on the block. Make sure no sealing material remains on the surface.

To install:

14. Lightly grease the new O-ring and place it on the pump. Do not use any other sealer. Carefully move the cover plate aside and install the new pump on the engine. Attach the pump retaining bolts; leave them loose at this stage.
15. Replace the cover plate retaining bolts and remount the bracket for the cooling fan and alternator.
16. Install the timing belt. Align the marks on the upper and lower gears with the marks on the belt. It is critical that the belt be refitted exactly as it was removed.

17. Draw tension on the belt by moving the water pump by hand. Tighten the water pump mounting bolts.

18. Install the lower timing gear cover and the vibration damper. Note that the damper can only be fitted one way--the pin on the crank gear must fit into the damper. Tighten the four bolts to 15 ft. lbs. (20 Nm). Install the large center nut, using the special tools as before. Tighten the center nut to 255 ft. lbs. (345 Nm).

19. Turn the engine clockwise ¼ turn. Use a belt tension gauge to check the timing belt tension. Adjust the tension by moving the water pump as necessary. If using Volvo tool No. 5197, the correct tension is 12.5 units.

20. Reinstall the front timing gear cover. Install the fan with its spacer and pulley. Tighten the fan bolts to 7 ft. lbs. (9 Nm).

21. Install the belts for the fan and power steering pump. Adjust the belts to the proper tension.

22. Reinstall the radiator. Connect the hoses to the radiator and the hose to the cold start device. Refill the coolant system with a 50-50 mixture of antifreeze and water.

23. Reconnect the negative battery cable. Start the engine and check for leaks.

24. Disconnect the upper hose to the cold start device. Place a collecting pan or jug beneath the hose and hold the hose level with the top edge of the expansion tank. Allow the engine to come to normal operating temperature with the cap off the expansion tank. Add coolant as necessary as the engine warms up.

25. When the coolant level is stable and no air is coming from the disconnected hose, shut the engine off. Reconnect the upper hose to the cold start device, top up the coolant in the expansion tank and put the cap back on the tank.

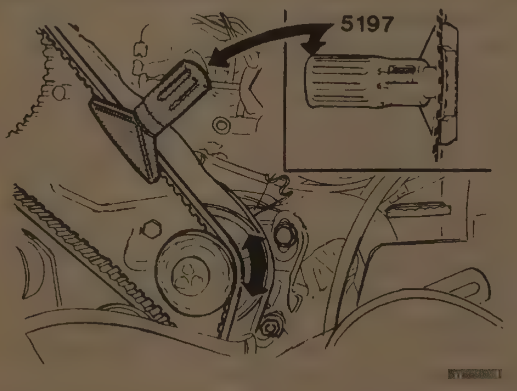

Fig. 96 Use a belt tension gauge and move the water pump as necessary to adjust the timing belt — Volvo special tool shown

Cylinder Head

REMOVAL & INSTALLATION

B20B and B30A Engines

➧ See Figures 97, 98 and 99

****WARNING**

To prevent warpage of the head, removal should be attempted only on a cold engine. All wires and hoses should be labled at the time of removal. The amount of time saved during reassembly makes the extra effort well worthwhile.

1. Drain the cooling system by opening the drain plug on the right-hand side of the engine and disconnecting the lower radiator hose at the radiator.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Disconnect the choke control cables at the carburetors. Remove the positive crankcase ventilation hoses from the air cleaner and intake manifold. Remove the vacuum hoses for the distributor advance and the power brake booster, if so equipped.

3. Remove the throttle control shaft from the pedal shaft, link rods, and bracket. (Disconnect the downshift linkage on cars with automatic transmissions).

4. Remove the air cleaner, inlet hose, and heat control valve hose from the engine.

5. Remove the upper radiator hose. Remove the heater hose clamp from the head.

6. Remove and plug the fuel line at the carburetors.

7. Label the spark plug wires and disconnect them from the plugs. Disconnect the coolant temperature sensor.

8. Remove the exhaust manifold preheating plate. Remove the nuts and disconnect the exhaust pipe from the exhaust manifold.

9. Unbolt the alternator adjusting arm from the head.

10. Remove the valve cover. Remove the rocker shaft and arm assembly as a unit and draw out the pushrods, keeping them in order.

11. Loosen the head bolts gradually, in the same order as their tightening sequence. Remove the head bolts, noting their locations, and lift off the head. Do not attempt to pry off the head. The head may be tapped lightly with a rubber mallet to break the gasket seal. If any residual water in the cooling passages of the head falls into the combustion chambers during removal, remove it immediately and coat the cylinder walls with oil.

12. Remove the integrally cast intake and exhaust (combination) manifold from the cylinder head.

13. Remove the old head gasket, flange gasket, and rubber sealing rings for the water pump.

14. Inspect the condition of the valves in the combustion chambers, and the intake and exhaust ports in the head. Small deposits may be removed with rotating brushes. If large deposits are present, however, proceed to Cylinder Head Reconditioning in the Engine Rebuilding portion of this section. Make sure that no foreign matter has fallen into the cylinders or onto the tops of the pistons. Thoroughly clean the mating surfaces of the cylinder head and block, removing any traces of the old head gasket. Check the mating surfaces for warpage. There is an oil feed hole for the rocker arm assembly on the tappet side, in the middle of the head. Make sure it is clean. A clogged oil feed hole may be opened with a length of thin gauge metal wire and some kerosene to dissolve the deposits. Clean the top of the cylinder head and the oil return holes to remove any gum or foreign matter. Clean and oil the head bolts.

To install:

15. Install the combination intake and exhaust manifold on the head with new gaskets.

16. Install new sealing rings for the water pump.

17. Use a pair of guide studs for proper alignment of the cylinder head, head gasket, and block. Guide studs can be easily made by cutting the heads off a pair of spare head bolts. The tops of the bolts are then filed to a tapered edge and slotted so that they may be installed and removed with a screwdriver. The guide studs should be installed in the cylinder block; one in the front right-hand head bolt hole, and the other in the rear left-hand head bolt hole.

18. Fit a new head gasket on the cylinder block with the lettering TOP (wide edge) facing up. Slide the gasket down over the two guide studs.

19. Carefully lower the cylinder head over the guide studs onto the block. Install, but do not tighten, two heads bolts at opposite ends to secure the gasket, and remove the guide studs. Install the remaining head bolts finger-tight. Tighten the head bolts in proper sequence first to 29 ft. lbs. (39 Nm), and then to 58 ft. lbs. (79 Nm).

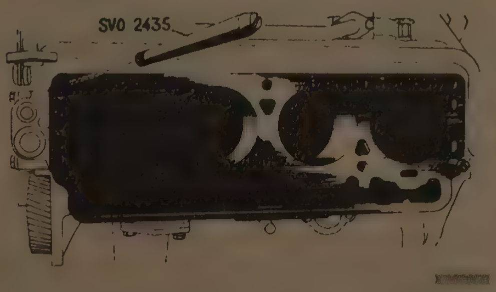

Fig. 97 Install the (temporary) guide studs to allow the cylinder head to mate properly to the block — Volvo factory guide stud shown

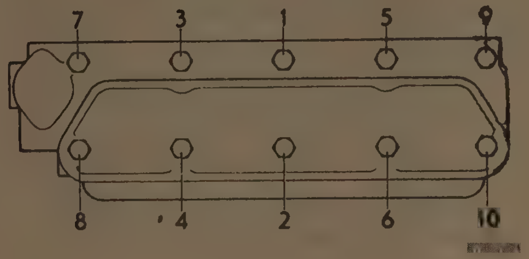

Fig. 98 Cylinder head tightening sequence — B20 engine

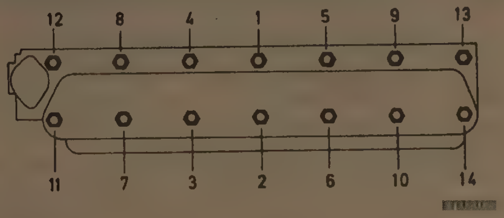

Fig. 99 Cylinder head tightening sequence — B30 engine

20. Roll the pushrods on a level surface to inspect them for straightness. Replace any bent pushrods. Install the pushrods in their original positions and install the rocker shaft and arm assembly. Tighten the bolts to approximately 20 ft. lbs. (27 Nm).

21. Adjust the valve clearance to 0.018-0.020 in. (0.45-0.50mm) for the B30A, and 0.022-0.024 in. (0.55-0.60mm) for the B20B. Install the valve cover with a new gasket.

22. Install the alternator adjusting arm and adjust the drive (fan) belt tension.

23. Install the following:
    a. Exhaust manifold preheating plate
    b. Exhaust pipe and flange nuts (with new gaskets)
    c. Spark plugs wires
    d. Coolant temperature sensor
    e. Heater hose clamp
    f. Upper and lower radiator hoses
    g. Fuel line
    h. Air cleaner

i. Inlet hose
j. Heat control valve hose
k. Choke and throttle linkage (down shift linkage on cars with automatic transmissions)
l. Vacuum hoses for the distributor and power brake (if so equipped)
m. The positive crankcase ventilation hose

24. Close the drain plug and fill the cooling system with a 50 percent antifreeze, 50 percent water solution.
25. Run the engine until it reaches operating temperature, then stop the engine
26. Remove the valve cover and tighten the head bolts in proper sequence to the final figure of 65 ft. lbs. (88 Nm).
27. Adjust the valve clearance to the final setting of 0.020-0.022 in. (0.50-0.55mm).
28. Install the valve cover.

B20E, 1972-73 B20F and B30F Engines

➧ See Figures 97, 98 and 99

The procedure for removal and installation of the cylinder head for the fuel injected engines differs from the carbureted engines only in the type of fuel system equipment that must be moved to gain access to the head.

✻✻WARNING

To prevent warpage of the head, removal should only be attempted on a cold engine. All wires and hoses should be labled at the time of removal. The amount of time saved during reassembly makes the extra effort well worthwhile.

1. Drain the cooling system by opening the drain plug on the right-hand side of the engine and disconnecting the lower radiator hose at the radiator.

✻✻CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Disconnect the negative battery cable from the engine.
3. On the B30F engine, remove the air cleaner.
4. Remove the following hoses from the inlet duct: pressure sensor, power brake (if so equipped), distributor advance, and crankcase ventilation (PCV).
5. Remove the electrical contacts for the throttle valve switch, cold start valve, thermal timer, temperature sensor, and injectors.
6. Remove the ground cable from the inlet duct and remove the cable harness.
7. Disconnect the sensor for the coolant temperature gauge. Remove the spark plug wires from the plugs.
8. On the B20E and B20F engines, remove the inlet hose.
9. Disconnect the throttle control cable from the throttle valve and inlet duct.
10. Remove the upper radiator hose.
11. Remove the heater control valve hose and the clamp for the heater pipe.
12. Unbolt the alternator adjusting arm from the head.
13. Remove the bolts for the inlet duct (intake manifold) stay. Remove the inlet duct-to-cylinder head retaining nuts and disconnect the inlet duct.
14. If any cleaning or machine work is to be performed on the cylinder head, remove the fuel injectors beforehand. Turn the lockrings on the injectors counterclockwise and lift out the injectors and distributing pipe as a unit. Remove the injector holders from the head.

✻✻CAUTION

The fuel system is under pressure. Release pressure slowly and contain spillage. Observe no smoking/no open flame precautions

15. Remove the exhaust manifold-to-exhaust pipe flange nuts and disconnect the pipe.
16. Remove the valve cover. Remove the rocker shaft and arm assembly as a unit and draw out the pushrods, keeping them in order.
17. Loosen the head bolts gradually, in the same order as their tightening sequence. Remove the head bolts, noting their locations, and lift off the head. Do not attempt to pry off the head. The head may be tapped lightly with a rubber mallet to break the gasket seal. If any residual water in the cooling passages of the head falls into the combustion chambers during removal, remove it immediately and coat the cylinder walls with oil.
18. Remove the exhaust manifold from the head.
19. Remove the old head gasket, flange gasket, and rubber sealing rings for the water pump.
20. Inspect the condition of the valves in the combustion chambers, and the intake and exhaust ports in the head. Small deposits may be removed with rotating brushes. If large deposits are present, however, proceed to Cylinder Head Reconditioning in the Engine Rebuilding portion of this section. Make sure that no foreign matter has fallen into the cylinders or onto the tops of the pistons. Thoroughly clean the mating surfaces of the cylinder head and block, removing any traces of the old head gasket. Check the mating surfaces for warpage. There is an oil feed hole for the rocker arm assembly on the tappet side, in the middle of the head. Make sure it is clean. A clogged oil feed hole may be opened with a length of thin gauge metal wire and some kerosene to dissolve the deposits. Clear the top of the cylinder head and the oil return holes to remove any gum or foreign matter. Clean and oil the head bolts.

To install:

21. Install the exhaust manifold on the head with a new gasket.
22. Install new sealing rings for the water pump.
23. Use a pair of guide studs for proper alignment of the cylinder head, head gasket, and block. Guide studs can be easily made by cutting the heads off a pair of spare head bolts. The tops of the bolts are then filed to a tapered edge and slotted so that they may be installed and removed with a screwdriver. The guide studs should be installed in the cylinder block, one in the front right-hand head bolt hole, and the other in the rear left-hand head bolt hole.

24. Fit a new head gasket on the cylinder block with the lettering TOP (wide edge) facing up. Slide the gasket down over the two guide studs.
25. Carefully lower the cylinder head over the guide studs onto the block. Install, but do not tighten, two heads bolts at opposite ends to secure the gasket, and remove the guide studs. Install the remaining head bolts finger-tight. Tighten the head bolts in proper sequence first to 29 ft. lbs. (39 Nm), and then to 58 ft. lbs. (79 Nm).
26. Roll the pushrods on a level surface to inspect them for straightness. Replace any bent pushrods. Install the pushrods in their original positions and install the rocker shaft and arm assembly. Tighten the bolts to approximately 20 ft. lbs. (27 Nm).
27. Adjust the valve clearance to 0.018-0.020 in. (0.45-0.50mm) for the B20E and B20F, and 0.022-0.024 in. (0.55-0.60mm) for the B30F. Install the valve cover with a new gasket.
28. If the injectors were removed, install the holders with new sealing rings. Install the injectors and distributing pipe as a unit.
29. Install the alternator adjusting arm and adjust the drive (fan) belt tensioner.
30. Install the inlet duct with a new gasket. Install the inlet duct retaining nuts and the bolts for the inlet duct stay. On B20 engines, install the inlet hose.
31. Install the following:
    a. Upper and lower radiator hoses
    b. Heater hose
    c. Exhaust pipe flange nuts
    d. Fuel line
    e. Throttle linkage
    f. Temperature gauge sensor
    g. Ground cable to inlet duct
    h. Cable harness
    i. Electrical contacts for the throttle valve switch
    j. Cold start valve
    k. Thermal timer
    l. Temperature sensor and injectors
    m. Pressure sensor hose
    n. Power brake hose
    o. Distributor advance line
    p. Crankcase ventilation hoses, and the battery cables.
32. On the B30F engine, install the air cleaner.
33. Close the drain plug and fill the cooling system with a 50 percent antifreeze, 50 percent water solution.
34. Start the engine and run it until it reaches normal operating temperature, then shut it off.
35. Remove the valve cover and tighten the head bolts in proper sequence to the final figure of 65 ft. lbs. (88 Nm).
36. Adjust the valve clearance to the final setting of 0.016-0.018 in. (0.40-0.45mm) for the B20E and B20F, and 0.020-0.022 in. (0.50-0.55mm) for the B30F.

1974-75 B20F Engine

✲✲WARNING

To prevent head warpage, removal should be performed only on a cold engine. All wires and hoses should be labled at the time of removal. The amount of time saved during reassembly makes the extra effort well worthwhile.

1. Drain the cooling system by removing the plug on the right side of the engine and disconnecting the lower radiator hose.

✲✲CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Remove the negative lead from the battery.
3. Disconnect hoses to brake vacuum booster and crankcase ventilation.
4. Remove the cold start injector hose and the fuel return hoses on both sides of the T-connection (at the control pressure regulator).
5. Remove the outlet fuel hose at the fuel filter and remove fuel filter with its clamp from the firewall.
6. Disconnect the fuel hose from the fuel distributor at the control pressure regulator.
7. Disconnect electrical wires at cold start injector, auxiliary air valve, control pressure regulator and temperature sensor.
8. Remove the air cleaner connecting pipe.
9. Disconnect the throttle cable at the intake manifold.
10. Disconnect the hose for heater and the upper radiator hose.
11. Remove the alternator adjustment bracket.
12. Remove the straps from the injector hoses. Remove the injectors and hoses from the cylinder head, by turning the lockrings counterclockwise.
13. Remove the bracket for the intake manifold, and remove the manifold.
14. Remove the exhaust manifold from exhaust pipe and cylinder head.
15. Remove the spark plugs and spark plug wires.
16. Remove the valve cover, rocker arm shaft and the pushrods.
17. Remove the cylinder head bolts and lift off the head. Take off the cylinder head gasket, the flange gasket and the rubber rings for the water pump.
18. Follow Steps 14, 16, 17, 18, 19 and 20 under Cylinder Head Removal and Installation for the B20B.
19. Install pushrods and rocker arm shaft. Adjust the valves to 0.018-0.020 in. (0.45-0.50mm).
20. Continue reassembly in the opposite order of disassembly. Tighten the manifold nuts to 18 ft. lbs. 24 Nm). Use care in refitting the fuel injection lines and maintain their cleanliness. When all hoses are attached and secure, refill the cooling system with a 50-50 mixture of antifreeze and water.
21. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.
22. Start the engine and allow it to reach normal operating temperature. Remove the valve cover and tighten the head bolts--in the correct order--to 65 ft. lbs. (88 Nm). Adjust the valves to their final setting of 0.016-0.018 in. (0.40-0.45mm). Replace the valve cover.

B21 and B23 Series Engines

➧ See Figures 100, 101, 102, 103, 104, 105 and 106

1. Disconnect the negative battery cable.
2. Remove the overflow tank cap and drain the coolant. Disconnect the upper radiator hose.

✻✻CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant may be reused unless it is contaminated or several years old.

3. Remove the distributor cap and wires.
4. Remove the PCV hoses.
5. Remove the EGR valve and vacuum pump.
6. Remove the air pump, and air injection manifold. Plug all open hoses, lines and ports.
7. Remove the exhaust manifold and header pipe bracket.
8. Remove the intake manifold. Disconnect the manifold brace and the hose clamp to the bellows for the fuel injection air/flow unit. Disconnect the throttle cable.
9. Disengage all vacuum hoses and electrical connectors to the fuel injection unit.

➡All wires and hoses should be labled at the time of removal. The amount of time saved during reassembly makes the extra effort well worthwhile.

10. Remove the fuel injectors.
11. Remove the valve cover.
12. Loosen the fan shroud and remove the fan. Remove the shroud. Remove the upper belts and pulleys.
13. Remove the timing belt cover. Remove the timing belt as described later in this section.
14. Remove the camshaft (if so desired) as outlined later in this section.
15. Remove the cylinder head (10mm Allen head bolts). Loosen the bolts in order opposite to the tightening sequence (10-9-8 . . . etc.).

To install:

16. Make sure the surface is clean and free of old gasket material. Use a new gasket and lightly oil the head bolts. Carefully place the head on the block and tighten the bolts in the prescribed order to 44 ft. lbs. (60 Nm). When all bolts are at 44 ft. lbs. (60 Nm), repeat the pattern and tighten to 81 ft. lbs. (110 Nm).
17. If the camshaft was removed, reinstall it.
18. Replace the timing belt. Follow the procedures listed under Timing Belt Installation and Removal later in this section.
19. Attach the upper belts and pulleys. Reinstall the fan and shroud.
20. Reinstall the valve cover.
21. Reinstall the fuel injectors.
22. Using new gaskets, attach the intake manifold. Secure its brace and attach the bellows for the air/flow unit. Reconnect the throttle cable.
23. Connect all vacuum lines and the electrical connectors to the fuel injectors.

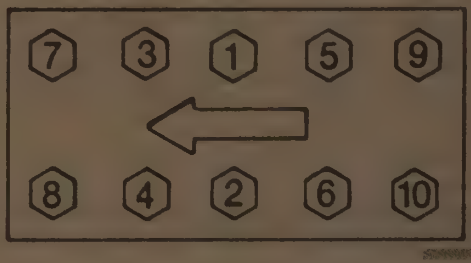

Fig. 100 Cylinder head bolt tightening sequence — B21 and B23 engines

Fig. 101 Use an extension and sufficiently long-handled breaker bar or ratchet to remove the cylinder head bolts

Fig. 102 Lift away the detached cylinder head from the block and place it in a safe location

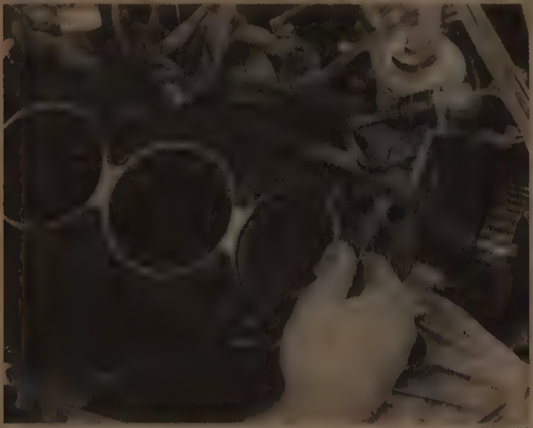

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Fig. 103 Remove the old cylinder head gasket and discard it

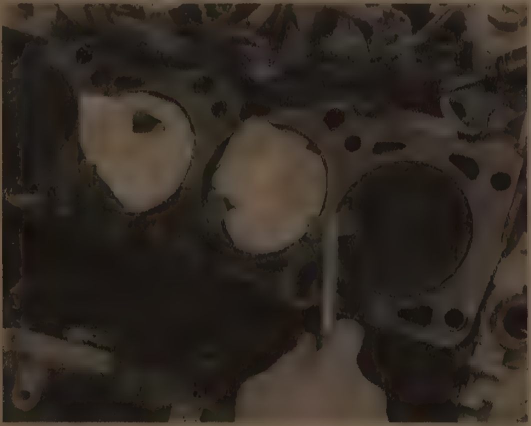

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Fig. 104 Clean any residual material so the mating surfaces are clean and smooth prior to reinstallation

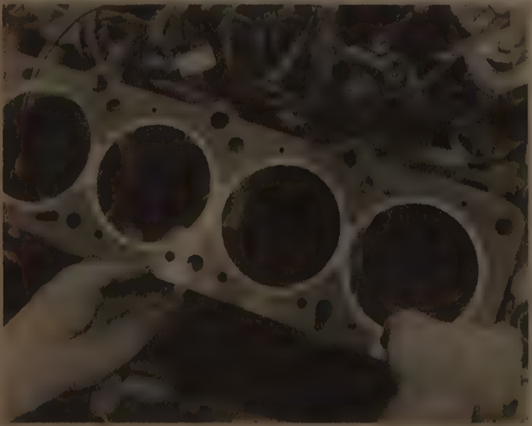

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Fig. 105 Use a new gasket aligned correctly on the block

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Fig. 106 Tighten the cylinder head bolts according to the correct torque figures in the proper sequence

24. Install the exhaust manifold and header pipe bracket.
25. Remembering to remove all of the plugs, reconnect the lines to the turbocharger if so equipped. If equipped with an air pump, reinstall it along with the air injection manifold.
26. Install the EGR valve and lines and connect the PCV hoses. Replace the distributor cap and wires.
27. Connect the hoses to the radiator. Fill the system with a 50-50 mix of antifreeze and water.
28. Reconnect the battery. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.
29. Start the motor and check for leaks. As the engine warms up, observe the coolant level and top off as needed.
30. When the engine has reached normal operating temperature, shut it off and allow it to cool for at least 30 minutes. Carefully remove the valve cover. Be careful; the engine parts will be hot.
31. Observe the correct tightening sequence and loosen each bolt enough to relieve any pre-tension. Tighten each bolt to 81 ft. lbs. (110 Nm) before loosening the next.
32. Perform any needed valve lash adjustments and replace the valve cover.

B230F Engine

➧ **See Figures 107, 108, 109, 110, 111 and 112**

1. Disconnect the negative battery cable.
2. Drain the coolant from the motor. Open the drain cock on the right side of the engine and connect a short piece of hose to prevent spillage.

✻✻CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Remove the valve cover. Remove the retaining nuts for the exhaust manifold. Gently pull the manifold off the studs just enough to allow clearance.

4. Remove the intake manifold. Follow the detailed instructions under Intake Manifold Removal and Installation earlier in this section.

5. Remove the fan, the fan shroud, and the clamp for the pre-heat hose, located under the fan shroud.

6. Remove the drive belts (loosen the adjustors as necessary) and remove the pulley for the water pump.

7. Remove the upper timing gear cover.

8. Remove the spark plugs. Remove the spark plug wires and distributor cap.

9. Use the center bolt of the crankshaft to turn the engine. Slowly rotate the engine until the mark on the camshaft pulley is opposite the mark on the inner timing gear cover. The crankshaft mark should align with the "0" on the lower timing gear cover. If the distributor is located on the side of the engine (not in the cylinder head), check that the rotor is aligned with the mark (notch) in the case of the distributor.

10. Remove the nut and washer for the timing belt tensioner. Pull on the timing belt to compress the tensioner spring. Use a 3mm drill bit to lock the tensioner spring. Remove the belt and the tensioner.

WARNING

Once the timing belt has been removed, do not allow either the crankshaft or the camshaft to turn while the cylinder head is on the car. The pistons may hit the valves causing severe damage.

11. Remove the camshaft gear and spacer. Do not allow the cam to turn during removal.

12. Remove the stud bolt for the timing belt tensioner.

13. Consult the head bolt diagram. Loosen the head bolts in REVERSE order to that shown in the diagram. (Begin with 10, then 9, 8, etc.) Remove the cylinder head. The head is made of aluminum alloy; when placing the cylinder head on the workbench, support the cylinder head on wooden blocks so that the gasket face is not scratched or gouged.

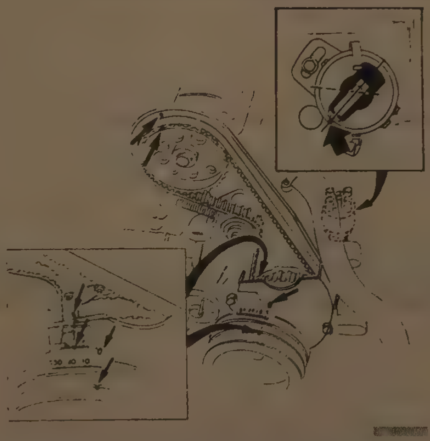


Fig. 107 Align the crankshaft and camshaft marks before removing the timing belt — B230F engines

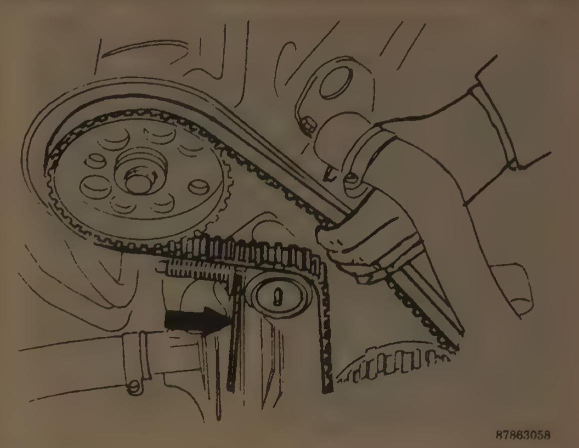


Fig. 108 Use a 3mm drill bit (indicated by the arrow) to hold the belt tensioner spring

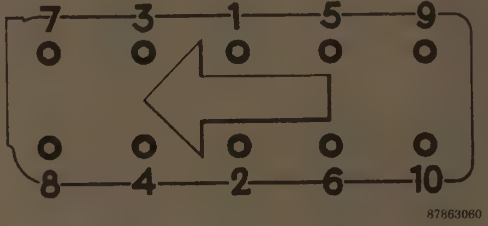


Fig. 109 Head bolt tightening sequence for the B230F. When removing, loosen the bolts in the reverse order

To install:

14. Check the position of the crankshaft. Number 1 piston should be at TDC. Check the position of the camshaft. The lobes for cylinder No. 1 should point at equally large angles. (Both valves are closed.)

15. Position the new head gasket and and the cylinder head. Make sure that the O-ring for the water pump is correctly placed in its groove. Remember that from this point, the camshaft and crankshaft must not be rotated or valve and piston damage may result.

16. Inspect the cylinder head bolts. Replace them if the center section shows any sign of stretching or other wear. If there is any doubt, replace them.

17. Apply a light coat of oil to the bolts and install them in the head. Using the sequence shown in the diagram, use a three stage tightening procedure:

First stage: Tighten all bolts to 14 ft. lbs. (19 Nm)
Second stage: Tighten all bolts to 43 ft. lbs. (58 Nm)
Third stage: Tighten all bolts exactly 90°.

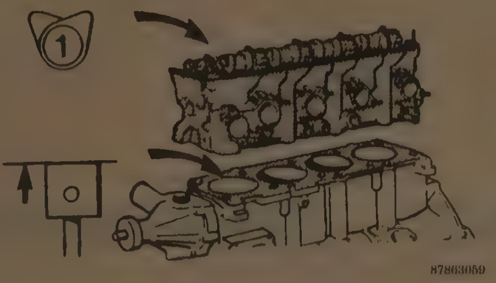


Fig. 110 Make sure the camshaft and No. 1 piston are in the correct position before placing the cylinder head on the block

➡During final tightening, you may opt to use Volvo tool No. 5098, a protractor used to precisely gauge the degrees rotation of the torque wrench.

18. Install the camshaft gear and spacer. Do not allow the cam to turn during installation.
19. Install the stud bolt for the belt tensioner, then install the tensioner with its washer and nut.
20. Double check that all marks on the cam and crank pulleys align as described in Step 9, above.
21. Place the timing belt around the crankshaft gear and intermediate shaft gear. Gently stretch the belt and place it over the camshaft gear and belt tensioner. Don't use sharp or pointed tools to pry on the belt.
22. Remove the drill bit from the tensioner. Double check that the camshaft and crankshaft pulleys are still in their exact, proper positions.
23. Rotate the engine one full rotation until it returns to top dead center and the marks align as before. Loosen the timing belt tensioner nut about one turn; the spring will set the correct tension on the timing belt. Retighten the nut.

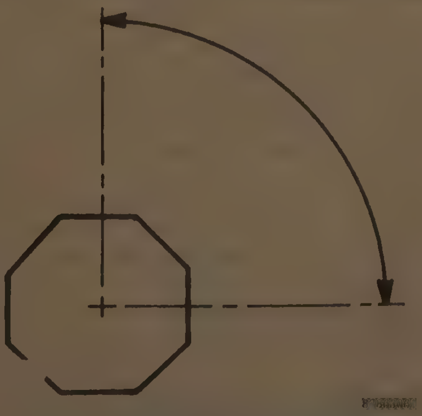


Fig. 111 For final tightening, turn the bolts an additional 90° as shown. Do not exceed the specified degrees

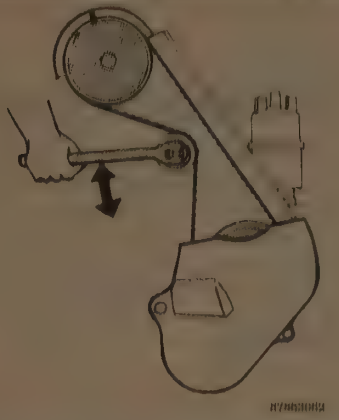


Fig. 112 Adjust the timing belt by loosening the tensioner bolt about one full turn and retightening. An internal spring will tension the belt

24. Adjust the valve lash if not done during head repairs or overhaul.
25. Install the valve cover with a new gasket.
26. Reinstall the intake and exhaust manifolds. Refer to the detailed instructions earlier in this section.
27. Replace the spark plugs, the distributor cap and the spark plug wires.
28. Reinstall the upper timing gear cover. Attach the water pump pulley and the drive belts.
29. Attach the fan and fan shroud. Reconnect the clamp and pre-heater hose. Adjust the drive belts.
30. If not already done, close the drain cock on the side of the engine. Refill the cooling system with a 50-50 mixture of antifreeze and water.
31. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.
32. Reconnect the battery cable. Start the engine and check for leaks. After the engine has come to normal operating temperature, check the coolant level and top off as needed.
33. While the head bolts DO NOT need to be retightened, the timing belt should be readjusted after 500-600 miles of driving. Remove the rubber plug in the timing gear cover, rotate the engine (turn the crankshaft pulley nut) to the TDC position on cylinder No. 1, and loosen the belt tensioner nut. The spring will correctly tension the belt; tighten the nut and replace the rubber plug.

B234F Engine

♦ See Figures 113, 114 and 115

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure.

1. Disconnect the negative battery cable.
2. Remove the heat shield over the exhaust manifold.

3. Remove the cap from the expansion tank and open the draincock on the right side of the motor. Collect the drained coolant in a suitable container.

✻✻CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Unbolt the exhaust pipe from the bracket, remove the manifold nuts and remove the manifold from the head.
5. On the left side of the motor, remove the support under the intake manifold. and remove the bottom bolt in the cylinder block.
6. Remove the manifold intact and tie it or support it safely.
7. Disengage the temperature sensor connectors, the heating hose under cylinders 3 and 4 and the upper radiator hose at the thermostat.
8. Remove the upper and lower timing belt covers.
9. Align the camshaft and crankshaft marks. Turn the engine to TDC on cylinder 1 and make sure the pulley marks and the crank marks align.
10. Remove the protective cap over the timing belt tensioner locknut. Loosen the lock nut, compress the tensioner (so as to release tension on the belts) and retighten the locknut, holding the tensioner in place.
11. Remove the timing belt from the camshafts. Do not crease or fold the belt.

✻✻WARNING

The camshafts and the crankshaft MUST NOT be moved when the belt is removed.

12. Remove the timing belt idler pulleys.
13. Remove the camshaft drive pulleys. Use a counterhold wrench to prevent the cam from turning.
14. Remove the plate or panel behind the pulleys. Remove the cover plate for the ignition wires. Label and disconnect the ignition wiring from the spark plugs and the distributor cap; remove the coil wire from the distributor cap.
15. Remove the valve cover and gasket. Clean the surfaces of any gasket remains.
16. Remove the distributor housing from the camshaft carrier. Remove the ignition wire clip next to the left bolt.
17. Plug the spark plug holes with crumpled paper. Remove the center bearing cap for each camshaft. Remove the third nut in the center. Mark the cam bearing caps for proper reinstallation.
18. Install a camshaft press tool, such as Volvo 5021 or similar on the exhaust side cam in place of the removed bearing cap. When it is securely in place, remove the remaining bearing caps and nuts. Remove the tool and remove the exhaust camshaft.
19. Remove the intake camshaft in identical fashion.

➡Label or identify each cam and its bearing caps. All removed components must be kept in order.

20. Using a magnet or a small suction cup, remove the tappets. Store them upside down (to prevent oil drainage) and keep them in order. They are not interchangeable!
21. Remove the remaining four nuts in the center of the cam carrier and detach the carrier from the head. If it is stuck, tap it very gently with a plastic mallet. Remove the O-rings around the spark plug holes.
22. Wipe the remaining oil off the cylinder head and remove the bolts in the order shown. When all the bolts are removed, the cylinder head may be lifted free of the car.

✻✻WARNING

The head is aluminum. Support it on clean wood blocks or similar to avoid scoring the face.

23. Clean the camshaft carrier and the head assembly of all gasket material and sealer. Carefully scrape the joint surfaces with a plastic scraper. Do NOT use metal tools to scrape or clean. Wash the surfaces with a degreasing compound and blow the surfaces completely dry. Inspect the head bolts for any sign of stretching or elongation in the midsection. If this is observed or suspected, discard the bolt. Bolts may not be used more than five times.
24. Install the new head gasket and a new O-ring for the water pump. Carefully place the cylinder head into position; do not damage the gasket.
25. Clean the head bolts and apply a light coat of oil. Install them and tighten (in the order shown) in three steps: All to 15 ft. lbs. (20 Nm), then all to 30 ft. lbs. (41 Nm). Third step is to tighten each bolt through 115° of arc in one continuous motion. The use of Volvo tool No. 5098 (protractor fitting) is strongly recommended for this task.
26. Install the exhaust manifold with a new gasket. Attach the front exhaust pipe to its bracket and install the heat shields.
27. On the left side of the motor, connect the temperature sensors, the heating hose under cylinders 3 and 4 and the upper coolant hose to the thermostat.
28. Fill the cooling system and check carefully for leaks, particularly around the head to block joint.
29. Install the intake manifold with a new gasket. Tighten the bottom bolts a few turns and place the manifold in position. Tighten all the bolts from the center outwards.
30. Reattach the support under the intake manifold and the cable clip. Double check all connections on and around the intake manifold.
31. Apply Volvo liquid sealing compound to the camshaft carrier. Use a small paint roller and coat the surfaces which match to the head and the bearing cap joint faces.
32. Install the cam carrier on the head and secure it with four of the five center nuts tightened to 15 ft. lbs. (20 Nm). Do not install the middle nut.
33. Oil all matching surfaces on the cam carrier, bearing caps and tappets.
34. Insert the tappets; they MUST be inserted in their original order and place.
35. Install the exhaust side camshaft by placing it in the carrier with the pulley guide pin facing up. Using the rear bearing cap as a guide, press the cam into place with the press tool. Install the bearing caps in the original order.

36. Install the bearing cap nuts and tighten them in stages to 15 ft. lbs. (20 Nm). Remove the press tool and install the center bearing cap; tighten it in stages to 15 ft. lbs. (20 Nm).

37. Install the intake camshaft in the carrier with the pulley guide pin facing upwards.

38. Turn the distributor shaft to align the driver with the markings on the distributor housing. Install new O-rings on the housing and rotor shaft.

39. Using the rear bearing cap as a guide, press the cam into place with the press tool. Install the bearing caps in the original order.

40. Install the bearing cap nuts and tighten them in stages to 15 ft. lbs. (20 Nm). Remove the press tool and install the center bearing cap; tighten it in stages to 15 ft. lbs. (20 Nm).

41. Install the center nut in the cam carrier and tighten it to 15 ft. lbs. (20 Nm).

42. Double check the tightness of all the camshaft carrier nuts and the bearing cap nuts. All should be 15 ft. lbs. (20 Nm). Do not overtighten.

43. Reinstall the distributor, connect the coil wire and install the ignition wire clip at the left bolt. Remove the paper plugs from the spark plug holes.

44. Use a silicone sealer and apply to the front and rear camshaft bearing caps. Install new gaskets for the valve cover and the spark plug wells. Install the spark plug gasket with the arrow pointing towards the front of the car and the word "UP" facing up. Make sure the valve cover gasket is correctly positioned and install the valve cover.

45. Reconnect the ground wire at the distributor.

46. Install the ignition wires and the cover plate.

47. Using a compression seal driver (Volvo tool No. 5025 or similar), install the oil seals for the front of each camshaft. Camshafts MUST NOT be allowed to turn during this operation.

48. Install the upper backing plate over the ends of the camshafts and adjust the plate so that the cams are centered in the holes.

49. Replace the idler pulleys and tighten their mounts to 18.5 ft. lbs. (25 Nm).

50. Install the camshaft drive pulleys, using a counterhold to prevent the cams from turning.

51. Making sure that the camshaft pulleys are properly aligned with the marks on the backing plate, position the timing belt so that the double mark on the belt coincides exactly with the top mark on the belt guide plate (at the top of the crankshaft). Place the belt onto the cam pulleys and make sure the single marks on the belt line up exactly with the marks on the pulleys. Fit the belt over the idler pulleys; right side idler first, then the left.

52. Double check that the engine is on TDC for cylinder 1 and that all the belt markings line up as they should.

53. Loosen the tensioner locknut. Rotate the crankshaft clockwise one full turn until the belt markings again coincide with the pulley markings.

✱✱WARNING

The engine must not be rotated counterclockwise while the tensioner is loose.

54. Turn the crankshaft smoothly clockwise until the pulley marks are 1½ teeth beyond the marks on the backing plate.

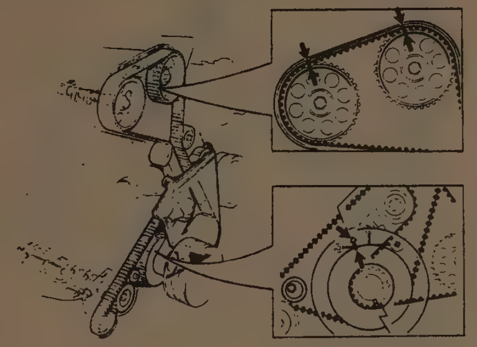


Fig. 113 Make sure all the marks align and the No. 1 cylinder is at TDC

55. Tighten the tensioner locknut. Install the lower timing belt cover.

56. Install the radiator fan and pulley, the alternator drive belt and the negative battery cable.

57. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

58. Start the engine and allow it to run until the thermostat opens. Use extreme caution--the moving timing belt is exposed!

➡This engine may be somewhat noisy when started. The noise will subside as oil reaches the tappets. Do not exceed 2500 rpm while the tappets are noisy.

59. Shut the engine off, rotate the crankshaft to bring the engine to TDC on cylinder 1 and use Volvo tool 998 8500 to check the belt tension. Correct deflection is 5.3-5.7 units when measured between the exhaust camshaft pulley and the idler. If the tension is not correct repeat Steps 51-54.

60. Install the upper timing belt cover.

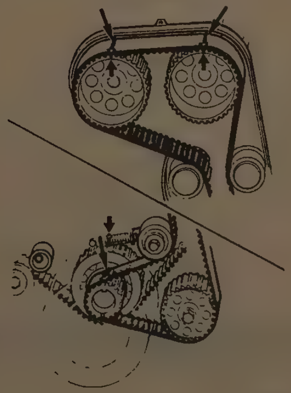


Fig. 114 Make sure the marks on the timing belt align with the pulley marks. Install the belt on the right side pulley first

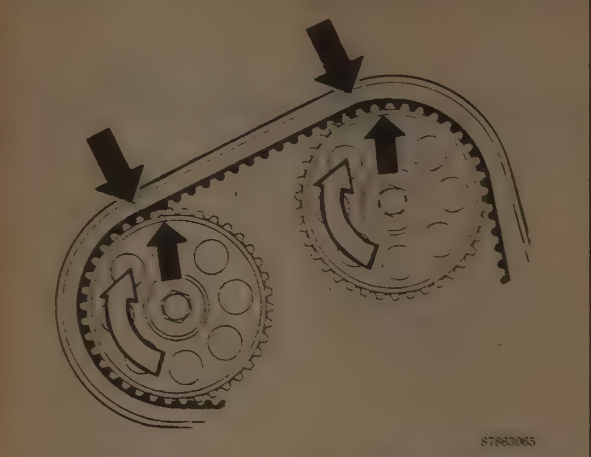


Fig. 115 Before tightening, ensure that the cam pulleys are in the correct position — B234 engines

61. Start the engine and final check all functions.

B28F and B280F Engines

➧ See Figures 116, 117, 118 and 119

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure. All wires and hoses should be labeled at the time of removal. The amount of time saved during reassembly makes the extra effort well worthwhile.

1. Disconnect the negative battery cable.
2. Drain the coolant.

✻✻CAUTION

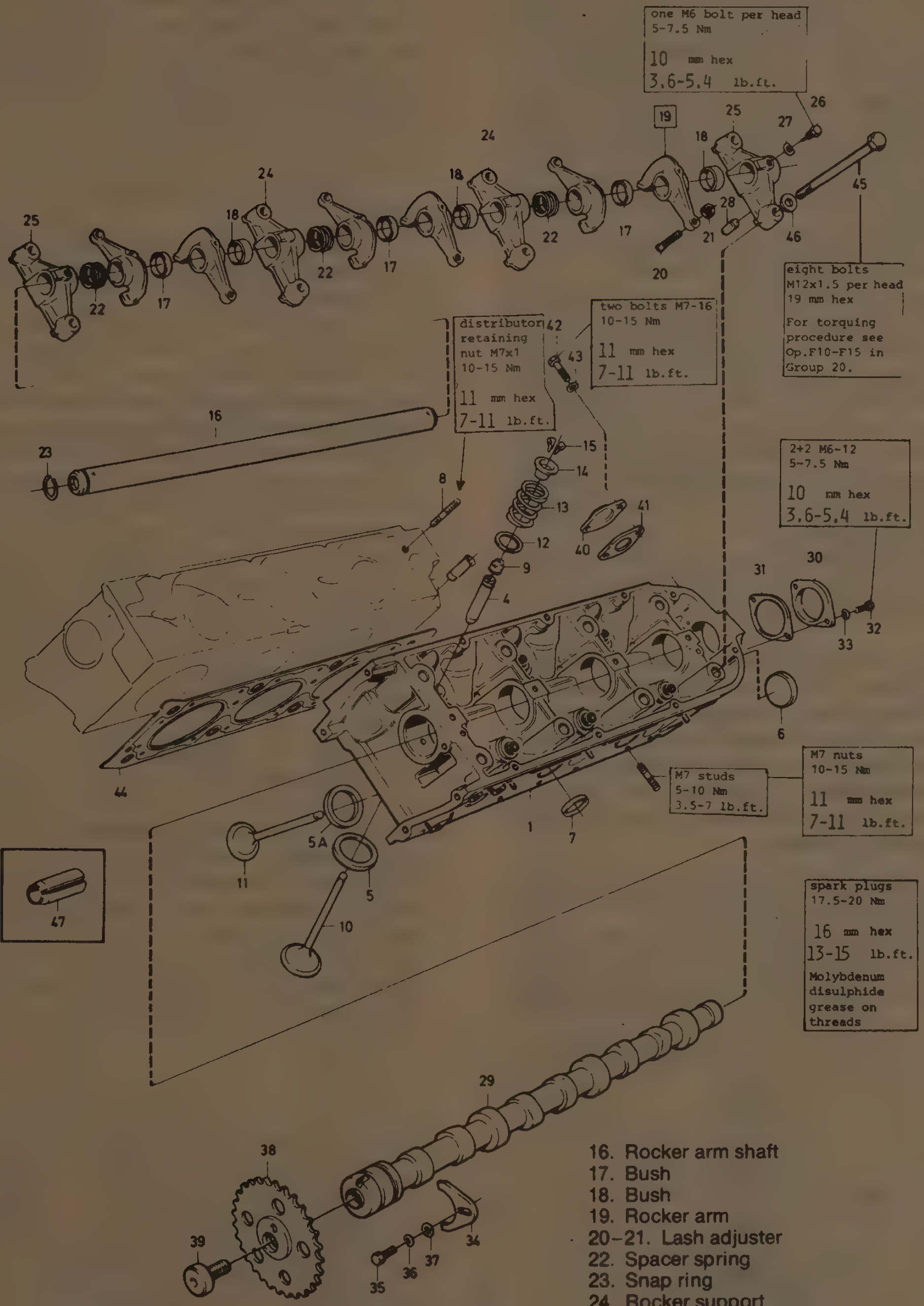
When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Remove the air cleaner assembly and all attaching hoses. On B28F and B280F engines, remove the intake air pre-heating hose and heat stove from the left side exhaust manifold, if that cylinder head is being removed.
4. Disconnect the throttle cable. On automatic transmission equipped cars, disconnect the kick-down cable.
5. Disconnect the EGR vacuum hose and remove the pipe between the EGR valve and manifold.
6. Remove the oil filler cap, and cover the hole with a rag. Disconnect the PCV pipe from the intake manifold.
7. Remove the front section of the intake manifold.

✻✻CAUTION

The fuel system is under pressure. Release pressure slowly and contain any spillage. Observe no smoking/no open flame precautions

8. Disengage the electrical connector and fuel line at the cold start injector. Disengage the vacuum hose, both fuel lines, and the electrical connector from the control pressure regulator.
9. Disengage the hose, pipe, and electrical connector from the auxiliary air valve and remove the auxiliary air valve.
10. Disengage the electrical connector from the fuel distributor. Remove the wire looms from the intake manifolds and disconnect the spark plug wires.
11. Disconnect the fuel injectors from their holders.
12. Disconnect the distributor vacuum hose, charcoal canister hose, and diverter valve hose from the intake manifold. Also disconnect the power brake hose and heater hose at the intake manifold.
13. Disconnect the throttle control link from its pulley.
14. On cars equipped with an EGR vacuum amplifier, disconnect the wires from the throttle micro switch and solenoid valve.
15. At the firewall, disconnect the fuel lines from the fuel filter and return line.
16. Remove the two attaching screws and lift out the fuel distributor and throttle housing assembly.
17. On cars not equipped with an EGR vacuum amplifier, disconnect the EGR valve hose from underneath the throttle housing.
18. Remove the cold start injector, rubber ring and pipe.
19. Remove the four retaining bolts and lift off the intake manifold. Remove the rubber rings.
20. Remove the splash guard beneath the engine.
21. If removing the left cylinder head, remove the air pump from its bracket.
22. Remove the vacuum pump and O-ring in the valve cover. Remove the vacuum hoses from the wax thermostat.
23. If removing the right cylinder head, disconnect the upper radiator hose.
24. On air conditioned models, remove the AC compressor. Use wire to tie it out of the way. Do not disconnect the refrigerant lines.
25. Disconnect the distributor leads and remove the distributor. Remove the EGR valve, bracket and pipe. At the firewall, disengage the electrical connectors at the relays.
26. On air conditioned models, remove the rear compressor bracket.
27. Disconnect the coolant hose(s) from the water pump to the cylinder head(s). If removing the left cylinder head, disconnect the lower radiator hose at the water pump. Disconnect the coolant temperature sensor.
28. Disconnect the air injection system supply hose from the applicable cylinder head. Separate the air manifold at the rear of the engine. If removing the left cylinder head, remove the backfire valve and air hose.
29. Remove the valve cover(s).
30. On the left cylinder head, remove the Allen head screw and four upper bolts to the timing gear cover. On the right cylinder head, remove the four upper bolts to the timing gear cover and the front cover plate.
31. From beneath the car, remove the exhaust pipe clamps for both header pipes on the B27F. On B28 and B280, carefully remove the oxygen sensor. Then remove the downpipe/crossover pipe above the catalytic converter and at the manifolds.


one M6 bolt per head
5-7.5 Nm
10 mm hex
3.6-5.4 lb.ft.
26
25
27
19
18
24
24
18
25
18
22
17
22
17
22
17
20
28
21
46
45
eight bolts
M12x1.5 per head
19 mm hex
For torquing procedure see Op.F10-F15 in Group 20.
distributor retaining nut M7x1
10-15 Nm
11 mm hex
7-11 lb.ft.
42
43
two bolts M7-16
10-15 Nm
11 mm hex
7-11 lb.ft.
16
23
8
15
14
13
12
9
4
41
40
2+2 M6-12
5-7.5 Nm
10 mm hex
3.6-5.4 lb.ft.
31
30
32
33
6
44
M7 studs
5-10 Nm
3.5-7 lb.ft.
M7 nuts
10-15 Nm
11 mm hex
7-11 lb.ft.
1
7
5A
11
5
10
47
spark plugs
17.5-20 Nm
16 mm hex
13-15 lb.ft.
Molybdenum disulphide grease on threads
29
38
39
34
37
36
35

1. Cylinder head
4. Valve guide
5. Intake valve seat
5A. Exhaust valve seat
6. Plug
7. Seal
8. Stud
9. Valve guide oil seal
10. Intake valve
11. Exhaust valve
12. Spring seat
13. Spring
14. Valve keeper
15. Collets
16. Rocker arm shaft
17. Bush
18. Bush
19. Rocker arm
20–21. Lash adjuster
22. Spacer spring
23. Snap ring
24. Rocker support
25. End rocker support
26–28. Rocker attachments
29. Camshaft
30–33. Camshaft rear cover
34–37. Camshaft retaining assembly
38. Camshaft sprocket
39. Sprocket bolt

Fig. 116 Exploded view of the head assemblies — B27F shown, B28F engine is similar

32. If removing the right cylinder head, remove the retainer bracket bolt and pull the dipstick tube out of the crankcase.

33. Remove the cover plate at the rear of the cylinder head.

34. Rotate the camshaft sprocket (for the applicable cylinder head) into position so that the large sprocket hole aligns with the rocker arm shaft. With the camshaft in this position, loosen the cylinder head bolts in sequence (same sequence as tightening), and remove the rocker arm and shaft assembly. If both heads are to be removed, label the left and right rocker assemblies so they are returned to the matching head; they are not interchangeable.

35. Loosen the camshaft locking bolt (directly in back of sprocket) and slide the locking plate to one side.

36. It is necessary to hold the cam chain stretched during camshaft removal. Otherwise, the chain tensioner will automatically take up the slack, making it impossible to reinstall the sprocket on the cam. To accomplish this, a special sprocket retainer tool (Volvo No. 5104) is installed over the sprocket with two bolts in the top of the timing chain cover. A bolt is then screwed into the sprocket to hold it in place. For the B28F and B280F engines, use special tool No. 5213. Fasten the tool to the timing gear cover and draw tension on the chain by turning the upper knob.

37. Remove the camshaft sprocket center bolts and push the camshaft to the rear, so it clears the sprocket.

38. Remove the cylinder head.

➡Do not remove the cylinder head by pulling straight up. Instead, lever the head off by inserting two spare head bolts into the front and rear inboard cylinder head bolt holes, and pulling toward the applicable wheel housing. Otherwise, the cylinder liners may be pulled up, breaking the lower seals and leaking coolant into the crankcase. If any do pull up, new liner seals must be used, and the crankcase completely drained.

39. Remove the head gasket. Clean the contact surfaces with a plastic scraper and lacquer thinner.

40. If the head is going to be off for any length of time, install liner holder (Volvo special tool No. 5093) or two strips of thick stock sheet steel with holes for the head bolts, so that the liners stay pressed down against their seals. Install the holders widthwise between the middle four head bolt holes.

41. When reinstalling, remember that the timing chain must be kept taut at all times. Install the guide sleeves (dowels) at the outboard corners of the block (if they were not removed, pull them up with a pair of narrow tipped pliers) and prop them up with a (3mm) drill shank inserted in the block hole. This will prevent the dowels from collapsing into the block when the head is installed.

42. Remove the liner holders which are clamped across the cylinders.

43. The right and left head gaskets are different. Remove any plugs and/or paper from the passages before placing the head gasket on the block.

44. Position the cylinder head on the block, making sure the guide dowels engage the holes in the head.

45. Slide the camshaft forward to engage the sprocket and install the center bolt. Make sure the head does not move. Double check that the cam is not caught in the locking fork and that the stud on the sprocket fits correctly into the groove in the camshaft. Remove the timing chain retainer tool.

46. Remove the drill bits below the guide dowels. Install the rocker arm assembly. Remember to install the rocker assemblies on the correct head if both heads were removed. The circlips (snaprings) on the end of the rocker shaft should face forward on the left side head and rearward on the right head.

47. The bolts threads should be clean and lightly oiled. Install the bolts finger-tight.

48. Tighten the bolts in the correct sequence and in three stages:
First stage: tighten all to 7 ft. lbs. (9 Nm)
Second stage: tighten all to 22 ft.lbs. (30 Nm)
Third stage: tighten all to 44 ft. lbs. (60 Nm). Note the time of day this tightening takes place.

49. Position the camshaft locking fork and tighten its bolt.

50. Tighten the camshaft center bolt. Use a 10mm hex key and tighten to 52-66 ft. lbs. (71-89 Nm). Use a small bar or other tool inserted through the sprocket to keep it from turning.

51. Install the four upper bolts in the timing gear case. Depending on which head was installed, either install the screw plug in the left side or the cover and washer on the right side.

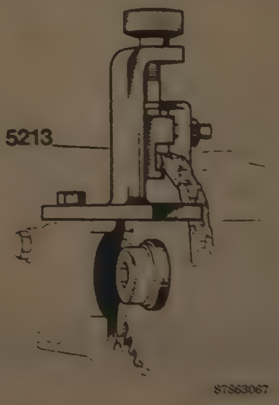


Fig. 117 Use the Volvo special tool to retain the timing sprocket and chain — shown attached to a B280 engine; B27 and B28 engines are similar

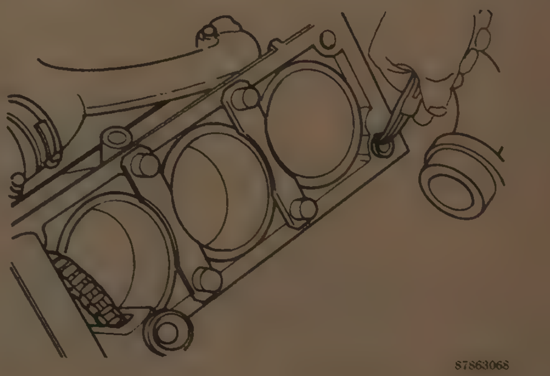


Fig. 118 B28 and B280 engines must have their cylinder liners held in place. Use Volvo tool or fabricate one of heavy sheet steel

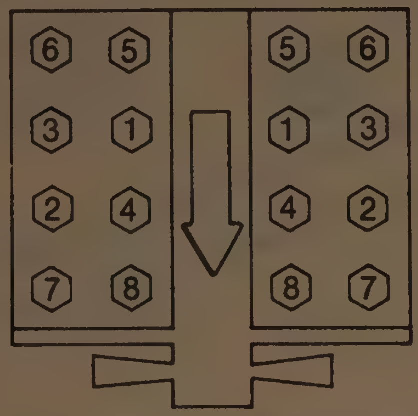


Fig. 119 Cylinder head bolt tightening sequence — B27 and B28 engines (arrow indicates front of engine)

Using a new gasket, install the cover(s) at the rear of the cylinder head(s).

52. If both heads were removed, install the other head by repeating Steps 40 through 49.

53. No less than 30 minutes after performing Step 46 (longer is better), loosen the head bolts in the same order in which they were tightened. When all are loose, tighten in the correct sequence to 13 ft. lbs. (18 Nm). The final setting is gained by tightening each bolt in the correct sequence through 115° of rotation.

54. With the head(s) properly tightened, check the valve lash and adjust adjust as necessary, following procedures outlined previously.

55. After adjusting the valves, turn the engine to its TDC/compression position. This aligns the crankshaft marks at zero and provides clearance at both valves for cylinder No. 1.

56. Install new gaskets and install the valve covers. Install only four bolts and do not tighten them excessively--the covers will be removed later on.

57. If the right cylinder head was removed, reinstall the dipstick tube and the dipstick. Secure the mounting bolt for the tube bracket.

58. Under the car, connect the exhaust system to the manifolds and connect the crossover pipe at the catalytic converter. Carefully reinstall the oxygen sensor.

59. If the left cylinder head was removed, install the backfire valve and connect the air hose. Install the air manifold at the rear of the engine.

60. Connect the coolant temperature sensor wiring. Install the coolant hoses to heads. Use new clamps to insure a good seal.

61. Install the rear compressor bracket if equipped with air conditioning.

62. Install the distributor making sure the rotor points toward the mark on the distributor body when installed. Place the distributor cap in position but DO NOT attach the clips or the spark plug wires. Damage may result when the intake manifold is installed.

63. Attach the EGR valve, bracket and pipe.

64. Connect the wiring to the relays at the firewall.

65. On air conditioned models, reinstall the compressor on its mounts. Install the belt and adjust it to the proper tension.

66. If the vacuum pump was removed, reinstall it, making sure the arm contacts the cam correctly. Use a new gasket and connect the hose properly.

67. Install the air pump if the left head was removed.

68. Use new rubber rings and install the intake manifold. Tighten the retaining bolts to 10 ft. lbs. (14 Nm).

69. Install the cold start injector with its line and seal.

70. Attach the fuel distributor and throttle housing assembly. Connect the EGR hose under the throttle housing.

71. Connect the fuel lines to the fuel filter and return lines.

72. Clamp down the distributor cap and install the spark plug wires.

73. If the car is equipped with a vacuum amplifier for the EGR system, connect the wiring to the throttle micro-switch and the solenoid valve.

74. Install the throttle cable to its pulley and, if automatic, the kick-down cable.

75. Connect the various vacuum hoses, observing the labels made during disassembly.

76. Connect the heater hose(s) at the intake manifold.

77. Reinstall the fuel injectors. Connect the wiring to the injectors and route the wiring properly along the intake manifold. Install the spark plug wires.

78. Install the auxiliary air valve and connect it to its wire and hose.

79. Connect the hose, both fuel lines and the wiring to the control pressure regulator.

80. Remove any plugs in the system and install the front sections of the intake manifold.

81. Install the oil filler cap, the air cleaner assembly, the preheat hoses and fittings if removed and the PCV pipe and valve.

82. Confirm that the draincocks in both the cylinder block and the radiator are closed and refill the engine with coolant.

83. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

84. Connect the negative battery cable.

85. Set the dashboard temperature control to maximum heat. Start the engine and allow it to warm up to normal operating temperature. During this time, closely examine the work area for signs of leakage. Since the valve cover(s) are not tightly retained, there may be some seepage. Don't tighten them yet.

86. Shut the engine off and allow it to cool for 30 to 45 minutes. Remove the valve covers. It may be necessary to remove the vacuum pump from the left-hand cover.

87. The final setting of the head bolts is accomplished by:

 a. Observe the loosening sequence chart. Loosen the first bolt only, then tighten it to 10 ft. lbs. (14 Nm), then angle-tighten it through 115° of motion.

 b. Repeat this procedure with the second bolt, the third and so on until all the bolts have been reset individually.

****WARNING**

DO NOT loosen all the bolts at once. Deal with each bolt individually and follow the correct sequence. If all the bolts are loosened, the head will lift and the gasket will need to be replaced.

88. Install the valve cover(s) with all the bolts. Tighten the bolts to 10 ft. lbs. (14 Nm). Install the vacuum pump with a new gasket if it was removed. Make sure the pump shaft meshes on top of the cam shaft.

89. Restart the engine. Check the ignition timing and idle speed and adjust if necessary. Install the splash shields.

D24 and D24T Engines

See Figures 120, 121, 122, 123 and 124

➡Due to the number of special tools needed to perform this operation, it is recommended that timing belt removal and installation be performed by a competent garage. However, if you have access to the required special tools, the procedure is given below.

1. Disconnect the negative battery cable.
2. Remove the splash guard and disconnect the exhaust pipe at the manifold and its transmission bracket. On the D24T model, disconnect all hoses to the turbocharger, and plug any open ports and hoses.
3. Remove the expansion tank after draining the radiator. Disconnect the lower hose at the cold start device on the fuel injection pump and point the end of the hose down to drain the block.

✲✲CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

4. Disconnect all remaining coolant hoses from the engine. Remove the vacuum pump and its plunger from the left side of the cylinder head.
5. Clean and remove the fuel delivery pipes. Plug all openings to prevent dirt contamination.
6. Disconnect the wire for the temperature gauge, the glow plug wires, the wire bundle for the rear glow plugs, the return hose from the rear injector, and the wire for the temperature gauge sender at the rear of the head.
7. Remove the valve cover and remove the front and rear timing belt cover.
8. Set the engine on No. 1 cylinder TDC compression stroke. Both camshaft lobes for cylinder no. 1 should point up at equally large angles and the flywheel timing pointer should be aligned with the 0 mark on the flywheel.
9. Remove the timing gear belt from the front camshaft gear by loosening the retaining bolts for the coolant pump and belt idler pulley.
10. Using a wrench to hold the gear (special tool No. 5199), remove the front gear center bolt. Do not allow the camshaft to turn at all. Remove the gear by tapping it off the camshaft.
11. Remove the injection pump drive belt by loosening the retaining bolts for the injection pump bracket to release belt tension. Tighten one bolt to hold the pump in the upper position after the belt is removed.
12. Remove the camshaft rear gear center bolt and gear while holding the gear with a wrench (special tool No. 5199). Access to the center bolt will be easier if special tool No. 5201 is used. Make sure the camshaft does not rotate.

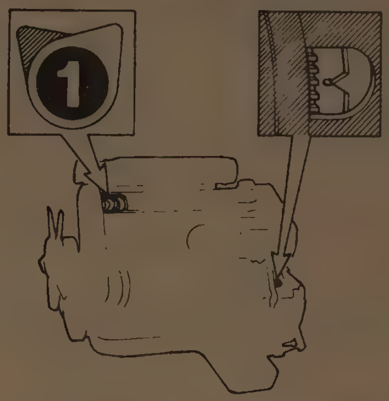


Fig. 120 Set the engine on No. 1 cylinder TDC compression stroke, and ensure that the camshafts and timing pointer are in the correct position

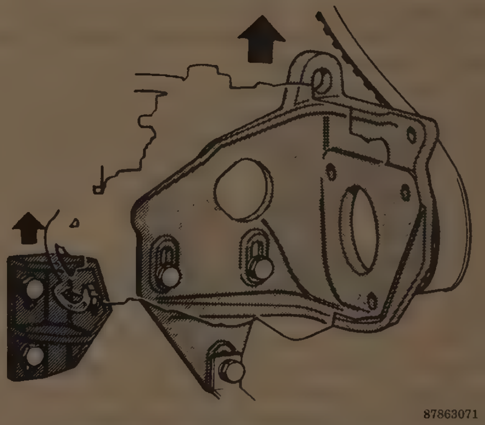


Fig. 121 Remove the injection drive pump by loosening the retaining bolts for the pump bracket

13. Remove the cylinder head bolts and remove the cylinder head. Position the head on wooden blocks so that the valves do not hold the weight of the head.
14. Use a steel ruler to check for head warpage. Lengthwise warpage cannot exceed 0.008 in. (0.2mm) and crosswise warpage cannot exceed 0.002 in. Warpage in excess of these tolerances requires replacing the head; it cannot be resurfaced.

To install:

15. Remove the rear glow plug so that it does not strike the injection pump bracket when installing.
16. Install special dowel pins (to center the head on the block) in the front and rear head bolt holes on the injection pump side of the engine (special tool No. 5189).
17. Install the new head gasket. There are three different thicknesses for gaskets, indicated by 1, 2 or 3 notches in the gasket. Use a gasket with the same No. of notches as were on the gasket just removed. Any time pistons, connecting rods or crankshaft are repaired or disassembled, piston projection

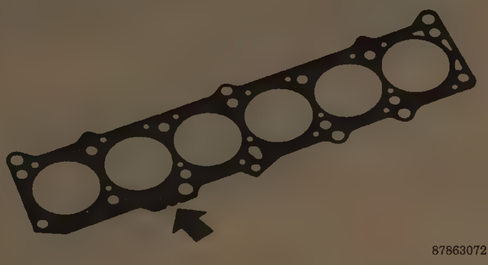


Fig. 122 Head gasket thickness is indicated by 1, 2 or 3 notches in the gasket

above the block deck must be measured and an appropriate gasket selected.

- Piston Projection: 0.026-0.031 in. (0.66-0.78mm); 1 Notch; Gasket thickness; 0.055 in. (1.4mm)
- Piston Projection: 0.032-0.035 in. (0.81-0.89mm); 2 Notches; Gasket thickness; 0.059 in. (1.5mm)
- Piston Projection: 0.036-0.040 in. (0.91-1.00mm); 3 Notches; Gasket thickness; 0.063 in. (1.6mm)

18. Set the engine to No. 1 cylinder TDC, if not already set.
19. Set the camshaft in position on the head so that both camshaft lobes on No. 1 cylinder point up at equally large angles (both valves closed). Lock the camshaft in this position by installing special tool No. 5190 in the slot in the rear of the camshaft.
20. Install the cylinder head. Install several of the head bolts, remove the dowel pins and install all of the head bolts. The threads and washers on the bolts should be oiled before installation. Tighten the bolts in two stages in the sequence shown: first all to 30 ft. lbs. (41 Nm), then all to 65 ft. lbs. (88 Nm).

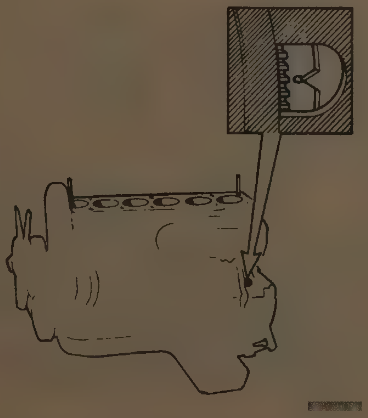


Fig. 123 Set the No. 1 cylinder to TDC as indicated by the pointer shown

21. From late 1980, new cylinder head bolts are used on the D24 Diesel. They are longer and 1mm wider. Torquing these bolts is a 6 step procedure:
    a. Tighten to 30 ft. lbs. (41 Nm)
    b. Tighten to 44 ft. lbs. (60 Nm)
    c. Tighten to 55 ft. lbs. (75 Nm)
    d. Tighten 180°, in one movement, without stopping.
    e. Run engine until oil temperature is minimum 120°F.
    f. Tighten 90°, in one movement, without stopping.
22. Install the bolts for the front belt shield.
23. Use wrench 5199 to hold the rear gear and use wrench 5201 to remove its center bolt. Remove the rear camshaft gear and remove the cover gasket.
24. Remove the front camshaft gear bolt using tool No. 5199 to hold the gear in position. Do not allow the camshaft to turn. Tap the gear loose.
25. Verify that No. 1 cylinder is still at TDC.
26. Using the cooling pump movement, adjust the belt tension. Install belt tension gauge 5197 on the belt. Set the gauge to 12.5. Adjust belt tension with the water pump until the mark on the plunger is flush with the gauge sleeve.
27. Press heavily on the belt with your hand and once again check the belt tension. Adjust if necessary.
28. Using wrench 5199 to hold the gear, tighten the front gear center bolt to 33 ft. lbs. (45 Nm).Make sure the camshaft does not rotate.
29. Remove the feeler gauge and the lock gauge at the rear of the engine.
30. Remaining installation proceeds in the reverse order of removal. After driving 600-1200 miles retighten the head with the engine warm to 62 ft. lbs. (84 Nm). Do not loosen the head bolts before retightening.

CLEANING & INSPECTION

See Figure 125

1. Clean all components parts with a suitable parts cleaner.
2. Remove the carbon deposits in the combustion chambers using a liquid carbon dissolving solvent. Clean the cylin-

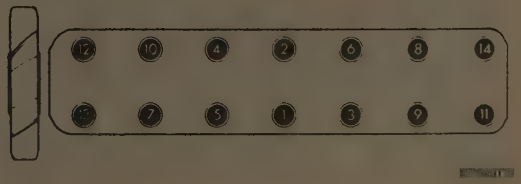


Fig. 124 Diesel cylinder head bolt tightening sequence; follow the reverse order (starting at No. 14) when loosening the bolts

der head face with a soft plastic scraper and paint remover or a liquid gasket striper.

3. Check the cylinder head(s), valve seats and valve guides for damage or cracks. You may wish to take the head to professional machine shop for chemical or dye crack checking. Cracks can occur internally where they cannot be seen with the naked eye.

CHECKING FOR HEAD WARPAGE

➧ See Figures 126 and 127

Lay the cylinder head down with the combustion chamber facing up. Place a straightedge across the gasket surface of the head, both diagonally and straight across the center. Using a flat feeler gauge, determine the clearance at the center of the straightedge. If the warpage exceeds 0.002 in. (0.05mm) in a span of 4 in. (100mm), the cylinder head must be replaced.

➡If the cylinder head exceeds specification it must be replaced; it cannot be machined.

Valves, Springs and Seals

➡Please refer to Section 2 for valve adjustment procedures.

REMOVAL & INSTALLATION

➧ See Figure 128

➡On all engines, the cylinder head(s) must be removed to service the valves.

B20 and B30 Engines

➧ See Figures 129, 130 and 131

Remove the valve springs by first compressing them with a standard valve spring compressor and removing the valve keys. (A small magnet can be very helpful for this.) Release

Fig. 125 An electric drill equipped with a wire wheel will expedite complete gasket removal

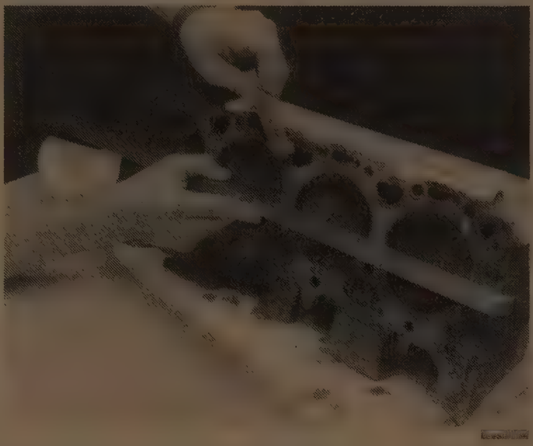


Fig. 126 Check the cylinder head for warpage along the center using a straightedge and a feeler gauge

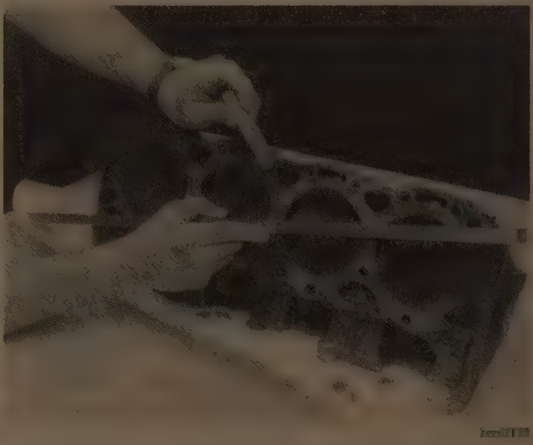


Fig. 127 Be sure to check for warpage across the cylinder head at both diagonals

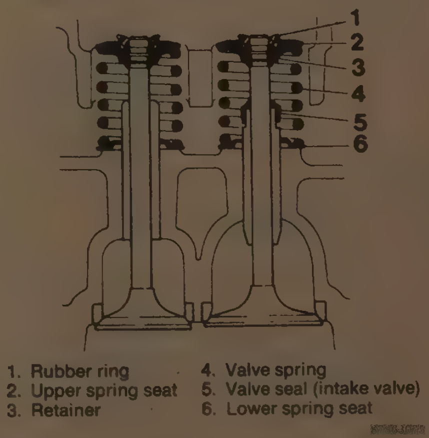


Fig. 128 Cutaway view of common valve spring components — B21F shown

the compressor slowly and remove the spring washer and valve.

Check that the parts are in good condition and clean them. Test the spring pressures and compare them with the specifications given in the valve specification chart in this section. Place the valve in position, fit the valve guide seal, valve spring, upper washer and the valve collets.

➡Valves must be installed in the same combustion chamber from which they were removed.

B21, B23, B230 and B234 Engines

➧ See Figures 132, 133 and 134

The camshaft must be removed to gain access to the valve spring. Please refer to Camshaft Removal and Installation for detailed instructions.

Remove the valve depressors and the rubber rings. Depress the valve springs with a C-clamp type depressor and remove the valve collets, the upper valve seat, the spring, the lower valve seat and the valve. Remove the valve stem seals from

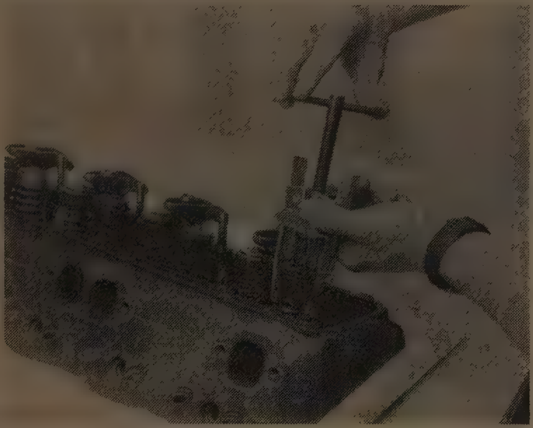


Fig. 129 Use a valve spring compressor tool to relieve spring tension from the valve caps

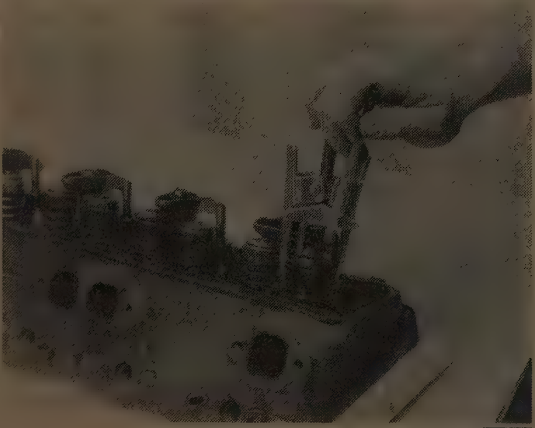


Fig. 130 A small magnet will help removal of the valve keys

Fig. 131 Be careful not to lose the valve keys

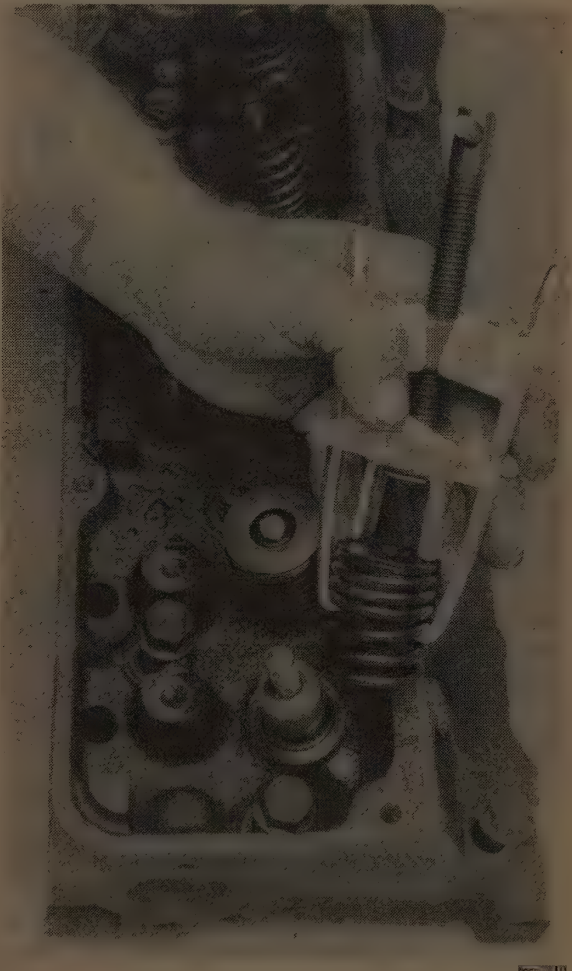
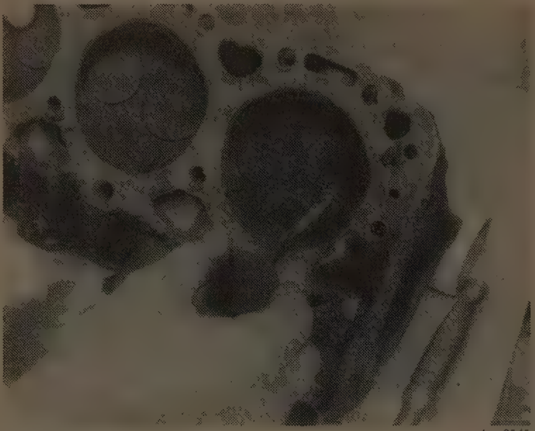
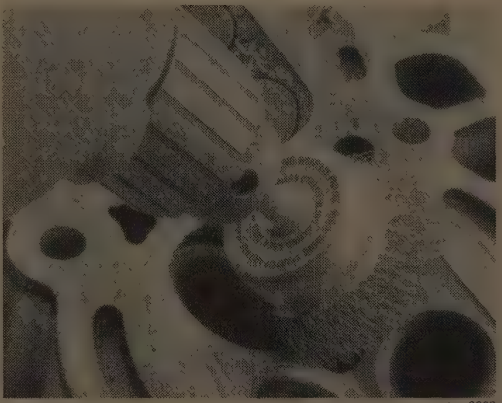


Fig. 132 Remove the spring from the valve stem in order to access the seal



tccs3141

Fig. 133 Invert the cylinder head and withdraw the valve from the cylinder head bore



tccs3802

Fig. 134 With the valves removed, a wire wheel may be used to clean the combustion chambers of carbon deposits — take care not to damage the aluminum

the intake valve guides. On B234 engines, remove the lower spring collars.

On B230 and B234 engines, remove the tappets (valve depressors) and keep them in order. During reassembly, they should be returned to the same location; they are not interchangeable.

To assemble, install new valve seals (intake valves only) and install the valve and spring assemblies in the reverse order of removal.

B27, B28 and B280 Engines

To gain access to the valves, the camshaft(s) must be removed from the head(s). Please refer to Camshaft Removal and Installation for detailed instructions.

To remove the valves, depress the valve spring with a valve spring compressor and remove the collets with a small magnet or similar tool. Release the tension on the spring compressor and remove the valve spring, its parts and the valve. Remove the valve guide seals.

To assemble, install new valve guide seals, being careful not to rip them when installing. After lapping the valves, assemble the valve spring parts in the reverse order of removal.

Diesel Engines

The camshaft must be removed. Please refer to Camshaft Removal and Installation for detailed instructions.

Remove the valve depressors and using a suitable spring compressor, compress the springs and remove the spring retainer collets. Release the compressor and remove the spring and valve assembly. Assemble in the reverse order. Be sure to fit new valve seals.

VALVE INSPECTION

▶ See Figures 135, 136 and 137

Minor pits or grooves may be removed from the valve face. However, discard any valves that are severely damaged. If the face runout cannot be corrected by refinishing or if the stem clearance exceeds specifications, the valve must be replaced. Discard any worn or damaged valve train parts.

REFACING THE VALVES

▶ See Figure 138

✽✽CAUTION

The valves in the B21F, B21FT, B230F, B230FT, B234F and ALL Diesel engines are stellite coated. This process provides extra heat insulation to the valve. These valves cannot be reground; grinding the face will destroy the coating. They may however be lapped-in (with paste) against the valve seat.

Using a valve grinder, resurface the valves according to specifications given earlier in this section.

➡Valve face angle is not always identical to valve seat angle.

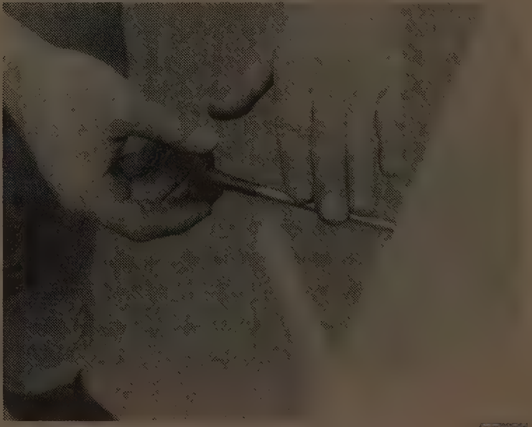


Fig. 135 Valve stems may be rolled on a flat surface to check for bends

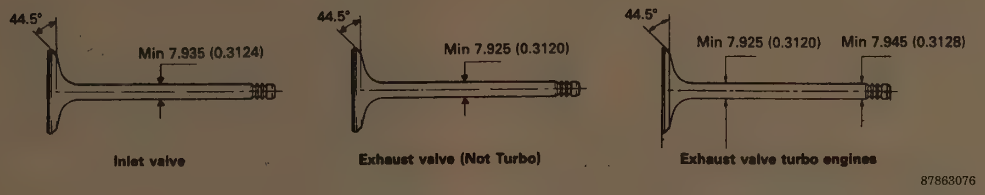

44.5°
Min 7.935 (0.3124)
Inlet valve
44.5°
Min 7.925 (0.3120)
Exhaust valve (Not Turbo)
44.5°
Min 7.925 (0.3120)
Min 7.945 (0.3128)
Exhaust valve turbo engines
87863076

Fig. 136 Check the valve stem diameter when the head is assembled — B230 valves shown

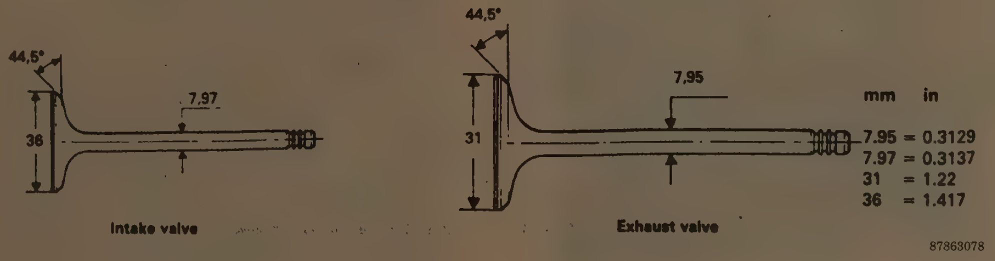

44,5°
36
7,97
Intake valve
44,5°
31
7,95
Exhaust valve
mm in
7.95 = 0.3129
7.97 = 0.3137
31 = 1.22
36 = 1.417
87863078

Fig. 137 Valve dimensions for the D24 and D24T diesel engines

A minimum margin of $^1/_{32}$ in (0.8mm). should remain after grinding the valve. The valve stem top should also be squared and resurfaced by placing the stem in the V-block of the grinder, and turning it while pressing lightly against the grinding wheel.

LAPPING THE VALVES

➡Before deciding to lap the valves, consult a reputable machine shop to determine if lapping is necessary. Some machine shops will perform this for you as part of the service, but the precision machining which is available today often makes lapping unnecessary. Additionally, the hardened valves/seats used in modern automobiles may make lapping difficult or impossible.

Invert the cylinder head, lightly lubricate the valve stems, and install the valves in the head as numbered. Coat valve seats with fine valve grinding compound, moisten the suction cup on the lapping tool and attach the cup to a valve head.

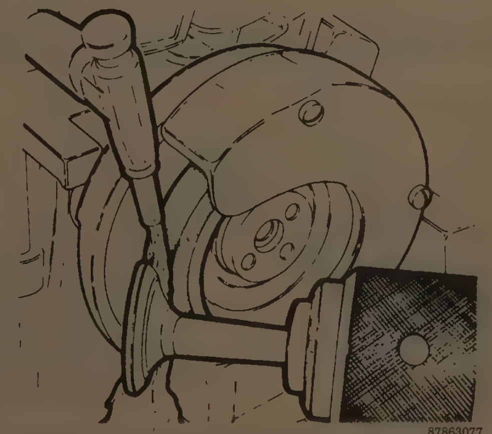


Fig. 138 Only grind the valves using the proper equipment

Rotate the tool, changing position and lifting the tool often to prevent grooving. Lap the valve until a smooth, polished seat is evident. Remove the valve and tool, and rinse away all traces of grinding compound.

CHECKING THE VALVE SPRINGS

➧ See Figures 139 and 140

Check the valve spring for proper pressure at the specified spring lengths using a valve spring pressure tool. Weak valve springs cause poor performance; therefore, if the pressure of any spring is lower than the service limit replace the spring.

Springs should be within 5 lbs. of all other springs. Check each valve spring for squareness. Stand the spring on a flat surface next to a carpenter's square. Measure the height of the spring; rotate the spring slowly and observe the space between the top coil of the spring and the square. If the spring is out of square more than 5/64 in. (2mm) or the height varies (by comparison) by more than 1/16 in. (1.5mm), replace the spring.

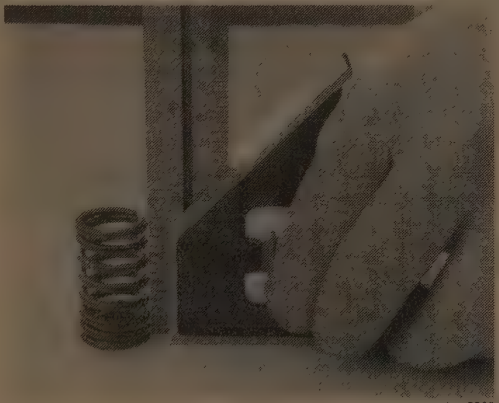

tccs3908

Fig. 139 Use a carpenter's square on a flat surface to check valve spring squareness — revolve the spring slowly to see any variance

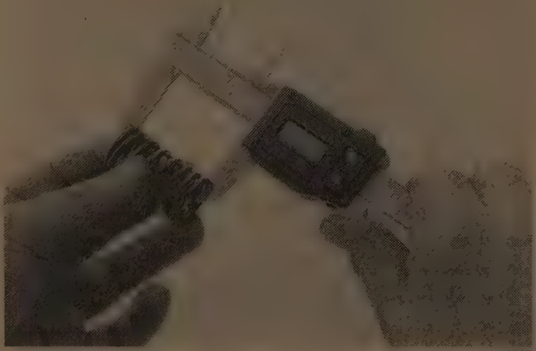

tccs3907

Fig. 140 Use a caliper gauge to check the valve spring free-length

Valve Guides and Seals

The valve guides are so named because they guide the stem of the valve during its motion. By properly locating the stem of the valve, the head and face of the valve are kept in proper relationship to the head. Occasionally, the valve guides will wear, causing poor valve sealing and poor engine performance. If this problem is suspected, check the sideways play of the valve within the guide.

If the play is minimal, it may not be necessary to replace the guides. A competent machine shop can knurl the guides. This process raises a spiral ridge on the inside of the guide, thereby eliminating the wobble and properly locating the valve. This is not a cure-all; it can only be done to correct minimal wear. Severe wear requires replacement of the valve guides.

REMOVAL & INSTALLATION

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure.

Gasoline Engines

➧ See Figures 141 and 142

The valve guides on the B20 and B30 engines can be pressed out with Volvo special tool No. 2818 and a press. New guides are installed with special tool No. 2819 and a press. Substitution tools can be used for either of these operations, however, when installing the new guides, distance A in the illustration must equal 0.689 in. (17.5mm) for all B20 and B30 engines except the B20E and the B20F. For the B20E and B20F, distance A should equal 0.705 in. (18mm).

The valve guides on the B21 and the B27/B28/B280 are also pressed out with tool No. 2818. When removing the valve guides on the B27/B28/B280 engines, place the cylinder head on the press so that the guide (not the head) is vertical. This

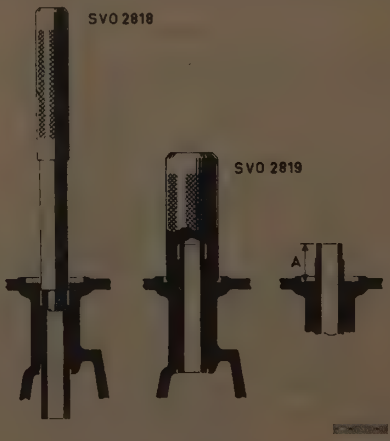


Fig. 141 Use special Volvo removal and installation tools or equivalents to install the valve guides

allows the guide to be pressed straight out and not at an angle to the press.

To fit new valve guides on the B21 and B23 engine, heat the head to approximately 140° F (60° C) in water and, using special tool No. 5027 for the intake valves and tool No. 5028 for the exhaust valves, press the valve guides in until the tool abuts the cylinder head.

The B230 head requires heating to 212° F (100° C); the installation tools are the same. If these tools are not available, press in the guides until the guide's height above the cylinder head surface, at the base of the guide, is 0.6061-0.6139 in. (15.4-15.6mm) for intake valve guides and 0.7051-0.7129 in. (17.9-18.1mm) for exhaust valve guides. When replacing the guides on the B230 engine, make sure the new guides have the same number of grooves at the end as the old guide. The number of grooves is an indication of the size of the guide.

B234 heads do not require heating but do require the guides to be installed under a minimum pressure of 2025 lbs. ((918.5 kg). The pressing operation is conducted in three steps with three different drifts of exact size. The final installation step leaves the top of the guide projecting above the head by 0.60 in. (15mm). The height is set by the installation tool.

After installing new guides, they must be reamed with a hand tool and the valves and seats must be ground (lapped).

On the B27/28 engines, the valve guides come in two oversizes. For oversize No. 1, the valve guide hole must be reamed out to 0.5195-0.5207 in. (13.20-13.23mm). For oversize No. 2, the hole must be reamed out to 0.5315-0.5326 in. (13.50-13.52mm). The grip in the cylinder head must be 0.0020-0.0037 in. (0.05-0.09mm).

After the holes have been reamed, press in the valve guides with special tool No. 5108 (for intake valves) and No. 5109 for exhaust. The correct pressing-in measurement for intake guides is 1.5551-1.5945 in. (39.5-40.5mm) and for exhaust guides 1.4370-1.4921 in. (36.5-37.9mm). After the guides are installed, ream them out to 0.3150-0.3158 in. (8.00-8.02mm) diameter.

The B28F and B280 heads require heating to about 300°F (149°C); it is generally outside the ability of the average home mechanic to safely deal with this level of heat. It is recommended that the head be taken to a machine shop for professional installation of new valve guides.

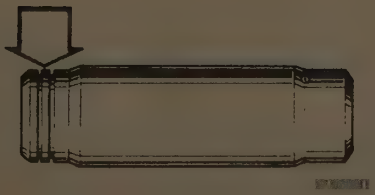


Fig. 142 When replacing the guides, make sure the new guides have the same number of grooves at the end as the old guide

The valve seats on all engines are removable. Since the usual method of removing and installing valve seats includes either freezing or heating the valve seat or the cylinder head, this job should be performed by a competent machine shop or garage. The intake valve seats on the B28 engine are of a new design and should not be replaced with the old style seats.

Diesel Engines

The valve guides are pressed out of the cold cylinder head toward the camshaft with an appropriate drift and press. To install a new guide, oil it lightly and press it into the cold cylinder head from the camshaft side. Press the guide in as far as it will go.

✻✻WARNING

Once the guide shoulder is seated, do not use more than one ton of pressure or you may break the guide shoulder.

Once installed, the guide must be reamed out to the appropriate diameter.The valve seats can be refaced but cannot be replaced. Reface the exhaust seats by hand only: do not use a machine.

Oil Pan

REMOVAL & INSTALLATION

B20 (Except 240 Series) and B30 Engines

The oil pan may be removed from the engine while the engine is still in the chassis.

1. Place supports on the frame side members. Insert a lifting hook into the plate bolted to the front of the engine. Using a lifting apparatus, raise the engine until there is no weight on the front engine mounts. Remove the oil dipstick.
2. Jack up the vehicle and place jackstands under the front jacking points. Drain the crankcase oil.

✻✻CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

3. Remove the lower nuts for the engine mounts. On 140 series models, remove the steering rods from the pitman arm and relay arm with a puller.
4. Place a hydraulic floor jack beneath the front axle member. Remove the rear bolts of the front axle member and replace them with two longer auxiliary bolts (UNC ½-13 x 114mm). Remove the front bolts for the front axle member and

lower the hydraulic jack, allowing the axle member to hang on the auxiliary bolts.

5. Remove the plug for the oil temperature gauge, if so equipped, and the reinforcing bracket at the flywheel.

6. Unscrew the oil pan bolts and lower the pan. Remove the old gasket and clean the surfaces of the cylinder block and oil pan. Remove any sludge or foreign matter that has accumulated at the bottom of the pan.

To install:

7. Using a new gasket, position the pan to the cylinder block and install the oil pan bolts. Tighten the bolts to 6-8 ft. lbs. (8-11 Nm).

8. Install the plug for the oil temperature gauge, if so equipped. Position the reinforcing bracket to the cylinder block and flywheel casing and install the bolts finger-tight. Snugly tighten the bolts for the flywheel casing and then those for the cylinder block.

9. Raise the hydraulic jack, lifting the front axle member, and tighten the front bolts. Remove the auxiliary bolts and install the original rear bolts of the front axle member.

10. Install the lower nuts for the front engine mounts. On 140 series models, connect the steering rods at the pitman arm and relay arm, and fit the nuts.

11. Remove the jackstands and hydraulic jack. Lower the vehicle. Remove the lifting apparatus.

12. Insert the dipstick. Fill the crankcase with the proper amount and grade of oil.

13. Start the engine and check for leaks.

B20 Engine — 1975 240 Series

On these models, the motor mounts are located high in the chassis, permitting more than 2 inches of clearance between the bottom of the oil pan and the steering linkage and suspension. Therefore, oil pan removal is a simple matter of unbolting the attaching bolts.

Always use a new gasket when installing the pan. A few dabs of oil-resistant sealer on the gasket at the front and rear main seals will help prevent oil leaks. Tighten the attaching bolts to no more than 6-8 ft. lbs. (8-11 Nm) of torque in a diagonal criss-cross pattern.

B21 Engines Built Prior to May, 1979

➧ See Figures 143, 144, 145, 146, 147 and 148

1. Attach lifting equipment or chain hoist to the lifting eye on the thermostat housing.

2. On air conditioned models, remove the compressor from its bracket to gain access to the motor mount.

3. Remove the retaining bolts for the left motor mount at the cylinder block.

4. Drain the crankcase.

✲✲CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

5. Remove the splash guard.

6. Raise the engine slightly.

7. Remove the left motor mount from the chassis.

8. Remove the engine-to-clutch housing brace.

9. Remove the oil pan retaining bolts. Tap the pan loose, swivel and remove.

To install:

10. Remove the old gasket and clean the surfaces of the cylinder block and oil pan. Remove any sludge or foreign matter that has accumulated at the bottom of the pan.

11. Using a new gasket, position the pan to the cylinder block and install the oil pan bolts. Tighten the bolts to 6-8 ft. lbs. (8-11 Nm).

12. Install the engine-to-clutch housing brace.

13. Reattach the left motor mount to the chassis and lower the motor to its normal position.

14. Attach the left motor mount to the cylinder block. When the engine is securely mounted, the lifting apparatus may be removed.

15. Fill the engine oil to the proper level.

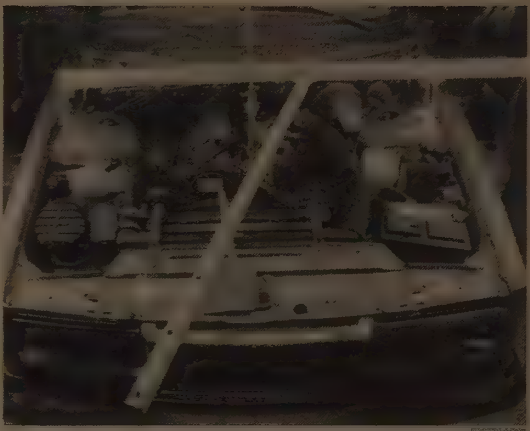


Fig. 143 Use a lifting tool, such as the one shown, to support the engine during oil pan removal

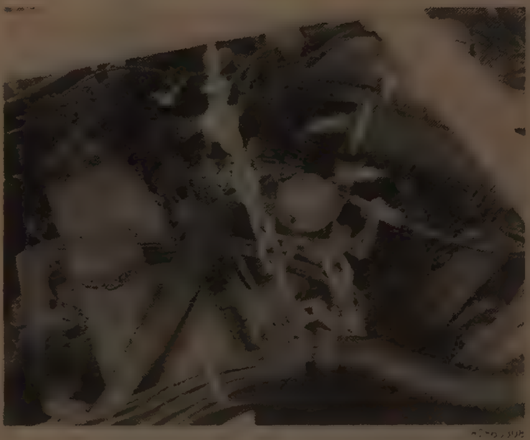


Fig. 144 Attach lifting equipment or a chain hoist to the lifting eye on the thermostat housing

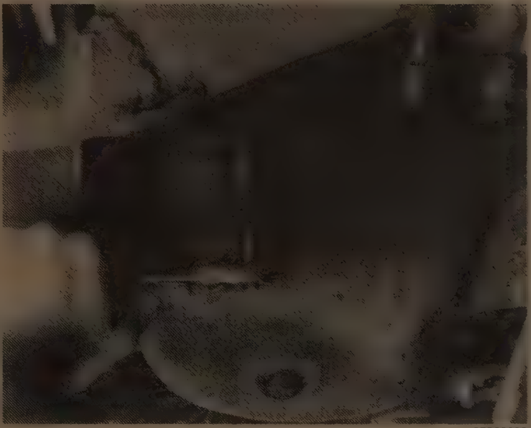


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Fig. 145 Use a socket and extension to remove the oil pan retaining bolts

Fig. 146 Tap the pan loose, swivel and carefully remove

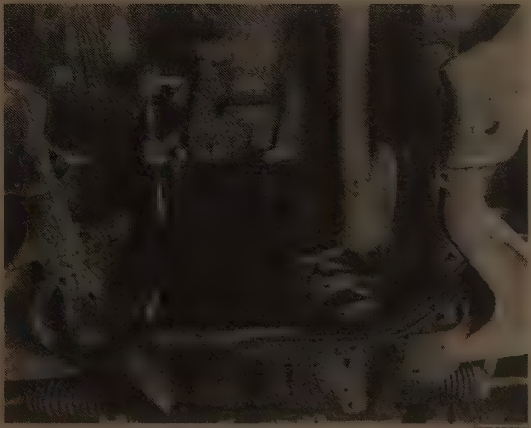


Fig. 147 The underside of the engine as viewed with the oil pan removed

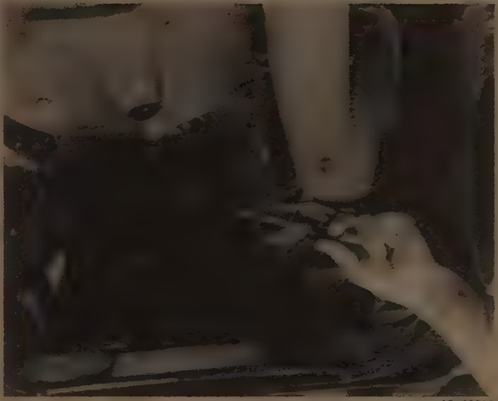


Fig. 148 Use a gasket scraper to clean the mating surfaces of the cylinder block to allow the new gasket to properly seal

16. Reinstall the air conditioning compressor if it was removed for access.
17. Start the engine and allow it to warm up to normal operating temperature. Check the pan area carefully for signs of leaks or seepage.
18. Install the lower splash shield.

B21 (Built May, 1979 and Later), B23 and B230 Engines

➧ See Figures 149 and 150

➡Due to the deeper oil pan on these models, the front axle member must be disconnected and lowered to remove the pan.

1. Raise the vehicle and support it on jack stands.
2. Disconnect the negative battery cable.
3. Drain the engine oil, then replace and tighten the drain plug.

✱✱CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

4. Remove the splash guard from underneath the engine. Disconnect the exhaust system at the flange in front of the muffler.
5. From underneath, remove the engine mount retaining nuts. On B23E and B230E models, it is also necessary to disconnect the bracket at the intake manifold.
6. Disconnect the steering shaft at the steering gear. On vehicles with manual transmissions, pull up the shield.
7. Lift the engine slightly using either a chain hoist or a crossbar lifter. Do not lift too high or other components will be damaged. It may be necessary to loosen the fan shroud to allow clearance during the lifting process.

8. On vehicles with power steering, disconnect the hose at the reservoir. Pinch or plug the line to prevent leakage and the entry of dirt. Place a jack under the front axle member for support. Remove the retaining bolts from the front axle member and lower it on the jack.

9. Remove the left side engine mount.

10. Remove the support bracket across the rear of the engine.

11. Remove the oil pan retaining bolts. Loosen, turn and remove the oil pan. Clean the gasket surfaces. Install the new gasket on the oil pan and install the pan. Tighten the bolts to 8 ft. lbs. (11 Nm). To reassemble:

12. Attach the reinforcing bracket. If the car has power steering, reconnect the lines at the reservoir.

13. Raise the front axle on the jack and install and tighten the retaining bolts.

14. Reconnect the steering shaft at the steering gear. The flange will only fit in one position.

15. Install the left side engine mount. On E-series motors, reconnect the bracket at the intake manifold.

16. Lower the engine into position. Fit the mount onto the front axle member. Disconnect and remove the lifting equipment when the engine is in position.

17. Install the dipstick and tube. Install and tighten the nuts on the engine mount.

18. Secure the fan shroud if it was loosened and install the splash guard under the engine. Attach the exhaust system at the muffler flange.

19. Return the car to the ground by safely removing the jackstands.

20. Fill engine oil to proper capacity. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

21. Start the engine and check carefully for leaks, particularly after the engine is warm.

B234 Engine

1. Safely elevate the car and support it on jackstands. Disconnect the negative battery cable and remove the engine oil dipstick.

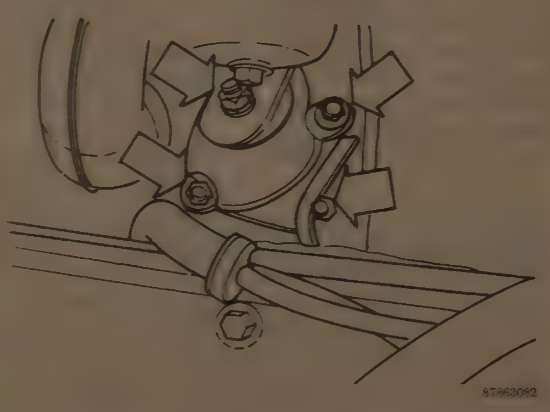


Fig. 149 Remove these nuts to detach the left side engine mount

2. Remove the air mass meter and air inlet hose. Loosen the fan shroud.

3. Remove the bolts at both ends of the crossmember.

4. Fit a chain hoist or lifting apparatus to the top of the engine and relieve the weight of the engine by lifting the at the front.

5. At the right motor mount, unbolt the bottom mounting plate from the crossmember. At the left motor mount, unbolt the upper mounting plate from the cylinder block.

6. Drain the engine oil and replace the drain bolt when the pan is empty. Use a new washer and tighten the bolt to 44 ft. lbs. (60 Nm).

✻✻CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

7. Remove the splash guard from under the engine, the bottom nut for the left motor mount and the wiring harness bracket from the transmission cover.

8. At the steering shaft, remove the lower clamping bolt and loosen the upper bolt. Matchmark the position of the splined joint and slide the fitting up the steering shaft.

9. Remove the rubber bumpstop on the front crossmember and remove the reinforcing bracket between the engine and transmission.

10. Disassemble the bolted joint at the front of the catalytic converter.

11. Carefully elevate the engine with the hoist. Make very certain that no hoses or wires are strained and that clearance is maintained at the firewall.Raise the motor only enough to perform the next steps of the procedure.

12. Remove the left motor mount.

13. Unbolt and remove the oil pan. It will need to be lifted and turned during removal.

14. Clean the gasket surfaces and install the new gasket (always!) so that the small tab on the gasket is on the same side as the starter. Lift the pan into place, install the retaining bolts and tighten them to 8 ft. lbs. (11 Nm).

15. Install the reinforcing bracket between the engine and transmission. Attach it first to the transmission and then to the engine block. Tighten the bracket in stages so that all the bolts pull up evenly.

16. Install the bumpstop on the front crossmember. Lift the crossmember into position against the side rails, install the bolts and tighten only a few turns to hold it in place.

17. When all the bolts are installed, tighten the crossmember bolts to 70 ft. lbs. (95 Nm). Install the left motor mount and secure the plate to the cylinder block. Don't forget to attach the cable clip on the upper bolt.

18. Paying close attention to the placement of the motor mounts, lower the engine into position. When the engine is correctly seated, the lifting equipment may be removed from the car.

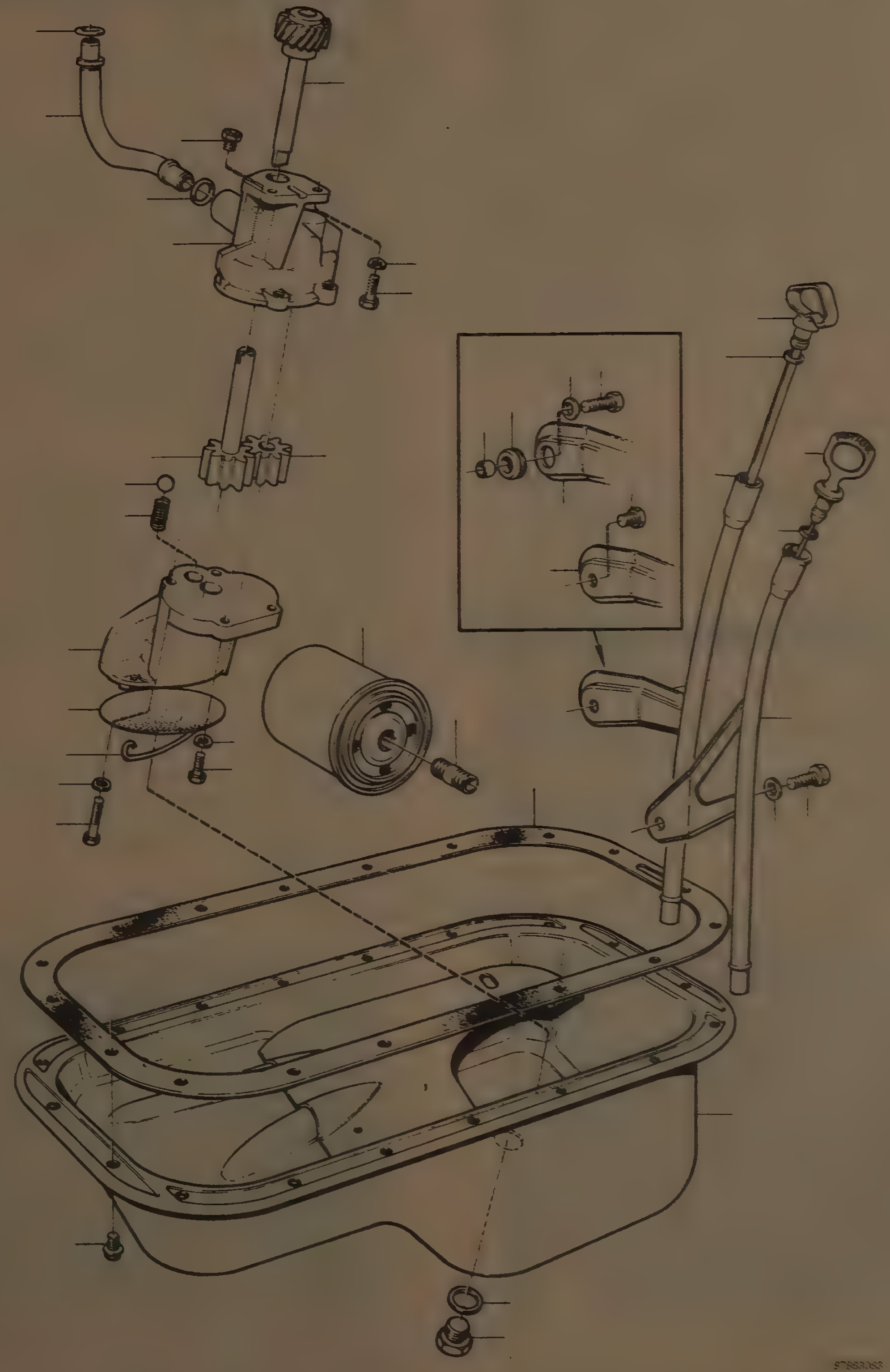


Fig. 150 Exploded view of the lubrication system and oil pan — B21 and B23 engines. B230 is similar

19. At the right motor mount, tighten the plate onto the crossmember. Check the connection of the air preheat tube at the exhaust manifold.

20. Tighten the fan shroud. Adjust the position of the bottom bracket as needed.

21. Reconnect the wiring harness bracket at the transmission, the bolted joint at the front of the catalytic converter and install the splash guard under the engine.

22. Tighten the left motor mount.

23. Observing the markings made earlier, reassemble the steering shafts. Insert and tighten the bottom bolt to 15 ft. lbs. (20 Nm). Tighten the upper bolt the same. Don't forget to install the small spring clips on the bolts.

24. Install the air mass meter and its hoses and connectors.

25. Fill the engine with the correct amount of oil and reinstall the dipstick.

26. Lower the car to the ground, reconnect the battery cable and start the engine. Check for leaks.

B27, B28 and B280 Engines

➧ See Figure 151

➡The following procedure is for the small steel oil pan at the front of the engine. This will not expose the crankshaft.

1. Remove the splash shield.
2. Drain the crankcase and reinstall the drain plug.

✻✻CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

3. Remove the oil pan retaining bolts. Swivel the pan past the stabilizer bar and remove the pan. Remove the old gasket and clean the surfaces of the cylinder block and oil pan. Remove any sludge or foreign matter that has accumulated at the bottom of the pan.

4. Using a new gasket, position the pan to the cylinder block and install the oil pan bolts. Tighten the bolts to 6-8 ft. lbs. (8-11 Nm). Fill the oil to the proper capacity and reinstall the splash shield.

Diesel Engine

The oil pan cannot be removed without either lifting the engine or removing it from the car. The combination procedure for removing the oil pan and the oil pump is found in Oil Pump Removal and Installation later in this section.

Oil Pump

REMOVAL & INSTALLATION

B20 and B30 Engines

The oil pump may only be removed with the engine elevated in the car or removed from the car. Do not attempt this procedure if you cannot properly lift and support the engine.

1. Remove the oil pan as described previously.
2. Crank the engine to TDC at no. 1 cylinder. Remove the distributor.
3. Remove the oil pump retaining bolts.
4. Detach the oil pump from the delivery tube by unscrewing the connecting flange. Be careful not to discard the rubber sealing rings from the sealing flange.
5. Unscrew the connecting flange and remove the delivery tube from the block.

To install:

6. Fit the delivery tube with its sealing rings to the oil pump, and then to the block. If the tube does not seat properly in the block, it may be tapped lightly with a soft mallet. Tightly screw the connecting flanges together.
7. With no. 1 cylinder at TDC, install the oil pump drive and distributor. Make sure that the shaft goes down into its groove in the pump shaft. Tighten the oil pump retaining bolts.
8. Install the oil pan with a new gasket and fill the crankcase.

B21, B23 and B230 Engines

➧ See Figures 152, 153, 154 and 155

1. Remove the oil pan as described previously.
2. Remove the two oil pump retaining bolts, and pull the delivery tube from the block.
3. When installing, use new sealing rings at either end of the delivery tube.

B234 Engine

1. Remove the timing belt following the procedures outlined in Timing Belt Removal and Installation.
2. Using a counterholding device such as Volvo tool No. 5039 or similar, remove the oil pump drive pulley.
3. Thoroughly clean the area around the oil pump. Place sheets of newspaper or a container on the splash guard to contain any spillage and remove the oil pump mounting bolts. Remove the pump from the engine.
4. Remove the seal from the groove in the block. Clean the area with solvent, making certain there are no particles of dirt trapped in the pump area.
5. Install the new seal in the groove and install the new oil pump. Lubricate the pump with clean engine oil before installation. Tighten the mounting bolts to 7.5 ft. lbs. (10 Nm).
6. Using the counterhold, install the drive pulley and tighten the center bolt to 15 ft. lbs. (20 Nm) PLUS 60° of rotation.
7. Clean the area of any oil spillage; remove the paper or container from the splash guard.
8. Install the timing belt following the procedures outlined in Timing Belt Removal and Installation.

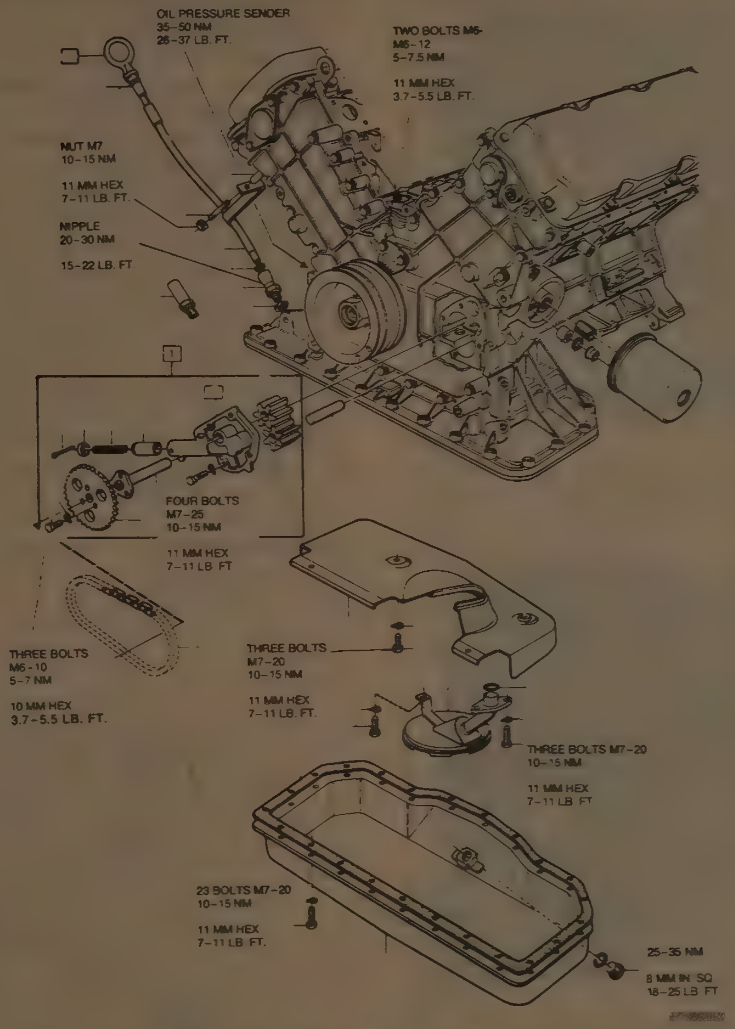
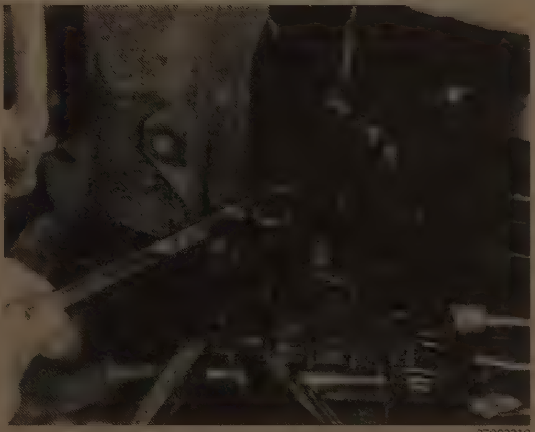

OIL PRESSURE SENDER
35–50 NM
26–37 LB. FT.
TWO BOLTS M6-
M6–12
5–7.5 NM
11 MM HEX
3.7–5.5 LB. FT.
NUT M7
10–15 NM
11 MM HEX
7–11 LB. FT.
NIPPLE
20–30 NM
15–22 LB. FT
1
FOUR BOLTS
M7–25
10–15 NM
11 MM HEX
7–11 LB FT
THREE BOLTS
M6–10
5–7 NM
10 MM HEX
3.7–5.5 LB. FT.
THREE BOLTS
M7–20
10–15 NM
11 MM HEX
7–11 LB. FT.
THREE BOLTS M7–20
10–15 NM
11 MM HEX
7–11 LB FT
23 BOLTS M7–20
10–15 NM
11 MM HEX
7–11 LB FT.
25–35 NM
8 MM IN SQ
18–25 LB FT

Fig. 151 Exploded view of components of the lubrication system — B27F engine shown, B28F and B280F are similar



57863312

Fig. 152 Remember to wear safety goggles as you look up to remove the two bolts to the oil pump

Fig. 153 Lower the oil pump, pulling the delivery tube to a point where you can better access it

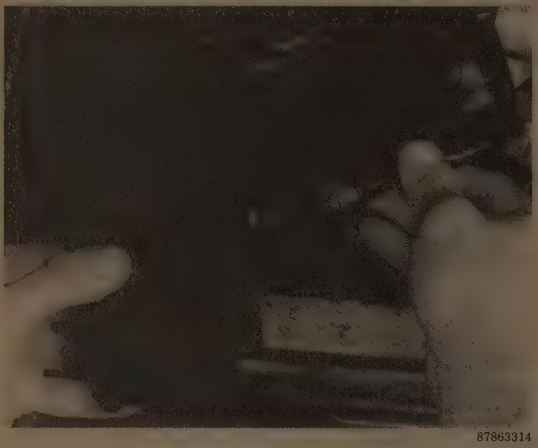


Fig. 154 Remove the delivery tube to free the oil pump — replace the sealing ring with a new one

Fig. 155 Replace the delivery tube sealing ring on the engine side of the tube as well

B27, B28 and B280 Engines

➧ See Figures 156, 157 and 158

The oil pump body is cast integrally with the cylinder block. It is chain driven by a separate sprocket on the crankshaft and is located behind the timing chain cover. The pick-up screen and tube are serviced by removing the oil pan. To check the pump gears or remove the oil pump cover:

1. Disconnect the negative battery terminal. Drain the coolant by opening the drain cock on the left side of the engine. A radiator hose may also be disconnected to speed draining.
2. After removing any electrical leads to the radiator, disconnect the oil cooler lines to the radiator on cars with automatic transmissions. Remove the fan shroud from the radiator, disconnect the hoses and remove the radiator. Remove the fan shroud.
3. Remove the splash shield under the engine. Loosen the alternator and power steering belts.
4. Remove the power steering pump from its bracket and secure it with wire out of the way. Do not disconnect any lines or hoses. After the pump is moved and secure, remove the bracket from the engine.
5. Detach and secure to one side the air conditioning compressor, if so equipped. Don't disconnect any lines or hoses.
6. Remove the fan, fan pulley and drive belts.
7. After removing the air intake duct and the vacuum pump, remove the left valve cover.
8. Using a 5mm Allen wrench, remove the fuel pressure regulator and lay it on the intake manifold. Disconnect the main ignition wire (near the right side shock tower) and remove the oil filler cap. Remove the right valve cover.
9. Turn the crankshaft to the overlap position on cylinder No. 1. This means the rocker arms for cylinder No. 1 do NOT have clearance and the first mark on the crank pulley is aligned with the O mark on the pointer.
10. Using either Volvo special tool No. 5112 or an acceptable substitute, lock the flywheel in position so that the engine cannot be moved out of position.
11. By using a 36mm socket, remove the crankshaft pulley. Take care that the small locking (Woodruff) key on the crankshaft does not fall into the lower part of the engine.

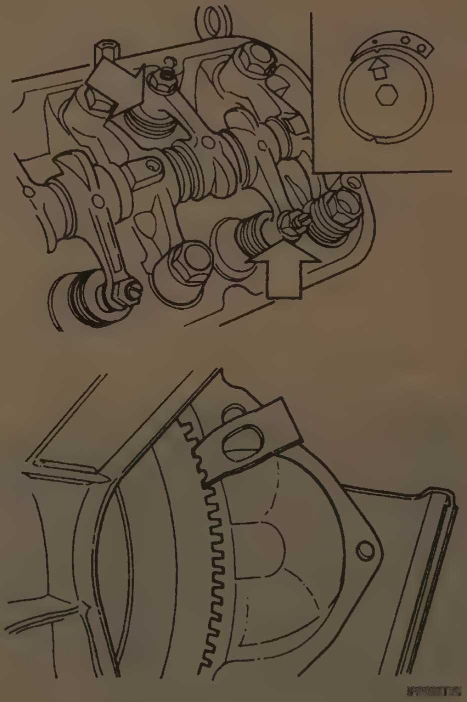


Fig. 156 Upper: set to the "overlap" position on cylinder No. 1 and set the crankshaft pulley to "0." Lower: lock the flywheel in place — Volvo special tool shown

12. Move the wiring harness on the timing cover to one side and remove the timing cover. The timing chains, gears, sliders and tensioners will be exposed. Do not loosen or meddle with any components or you may cost yourself great time and expense.

13. Remove the oil pump sprocket and its chain. This is the outermost drive system and can be removed with no disturbance of the other chains. The oil pump itself may now be removed by loosening its retaining bolts and carefully lifting it away from the engine. Clean all the parts before reinstallation. Clean the housing in the cylinder block. Install the pump and tighten its mounting bolts to 7-11 ft. lbs. (9-15 Nm).

14. Using a plastic (not metal) scraper, clean the gasket surfaces on the timing cover, the valve covers, and the front of the engine block. Tap the center seal out of the timing cover and replace it with a new one.

15. Reinstall the oil pump drive pulley and its chain. Use a light coat of locking fluid on the pulley retaining bolts.

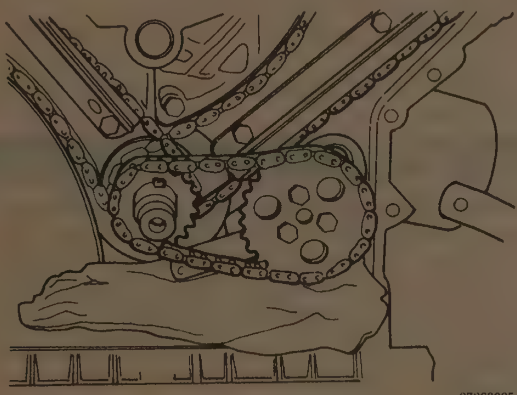


Fig. 157 Remove the oil pump sprocket and its chain — B28 and B280 engines

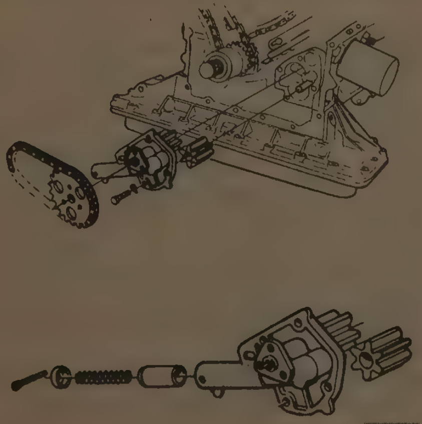


Fig. 158 Exploded view of the oil pump and mounting position — B28 and B280 engines

16. Install the timing gear cover with a new gasket. Apply a light coat of locking fluid to the four lower bolts; tighten all the bolts to 10-11 ft. lbs. (14-15 Nm).

17. Install the crankshaft pulley. Tighten to 190-200 ft. lbs. (258-271 Nm). Remove the locking device from the flywheel.

18. Apply new gaskets and reinstall both valve covers.

19. On the right side of the motor, replace the oil filler cap, the ignition lead and the fuel control pressure regulator.

20. Close the drain cock on the left side of the engine.

21. On the left side of the motor, reconnect the vacuum pump (with a new gasket) and the air inlet duct.

22. Reinstall the fan, pulley, and drive belts. Replace the bracket and the power steering pump with its belt. Adjust all the belts to the correct tension.

23. Install the air conditioning compressor and set the belt tension.

24. Install the fan shroud and the radiator. Connect the oil cooler lines to the radiator (cars with automatic transmission), and connect all the hoses to the radiator. Reconnect any wiring to sensors on the radiator.

25. Install the splash guard under the car.

26. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

27. Reconnect the battery cable. Fill the cooling system with a 50-50 mixture of coolant and water. Start the engine and check for leaks. After the engine has fully warmed up, check the coolant level and top up as needed.

D24 and D24T Diesel Engines

➧ See Figures 159, 160, 161, 162, 163 and 164

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure. This procedure covers removal of both the oil pump and the oil pan. While it is easier to do this with the engine out of the car, the repair can be performed with the engine lifted and supported while still in the vehicle.

1. Disconnect the negative battery cable.

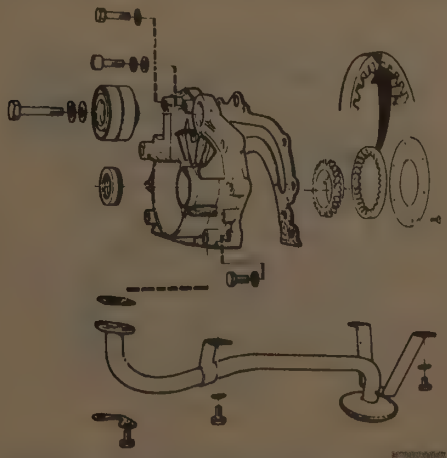


Fig. 159 Exploded view of the diesel oil pump assembly

2. Drain the coolant system by disconnecting the lower radiator hose at the radiator and disconnect the lower hose of the cold start device.
3. Remove the radiator. Remove the cooling fan with its spacer and pulley.
4. Remove the fan belt(s) and the power steering drive belt.
5. Remove the timing gear cover. When this cover is removed, the timing belt will be exposed. Do not allow fluids, dirt or oil to contact the belt. It must be kept clean and dry or premature wear and breakage may result.
6. Remove the large center bolt in the center of the vibration damper (pulley) and the crankshaft. Do not allow the pulley to turn while removing the nut. Volvo has two special tools available to accomplish this.
7. When the nut is removed, turn the pulley (and therefore, the engine) about ¼ turn counter clockwise. This transfers the slack in the timing belt to the opposite side, making it easier to remove.
8. Using a 6mm Allen wrench, remove the four small bolts holding the crank damper and remove the damper. Note that the crankshaft gear may stick to the damper. When the damper is off, remove the lower timing gear cover.
9. Loosen and remove the three bolts holding the bracket for the alternator and cooling fan. Place the assembly to one side and secure it out of the way.
10. Mark the position of the timing belt relative to the timing gears. Mark the belt, camshaft gear and crankshaft gear. Identify the outside and topside of the belt. It is critical that the belt be reinstalled in exactly the same position as it was found.
11. Loosen the water pump mounting bolts and and the timing belt. Some coolant may leak out when the bolts are loosened. Remove the timing belt.
12. Remove the idler pulley. Use a pulley puller; do not pry on the idler.
13. Remove the seal from the oil pump. Remove all the retaining screws from cover, but do not remove the cover at this time.
14. Lift the dipstick about 2½ inches and remove the upper retaining bolt from the steering joint. Remove the wire from the oil level sender if so equipped.

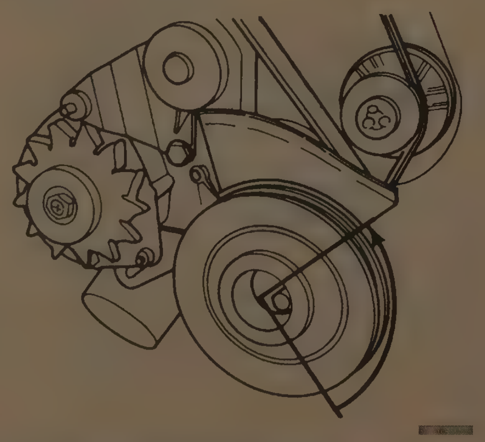


Fig. 160 Turn the engine about 1/4 turn counterclockwise to transfer the slack in the timing belt

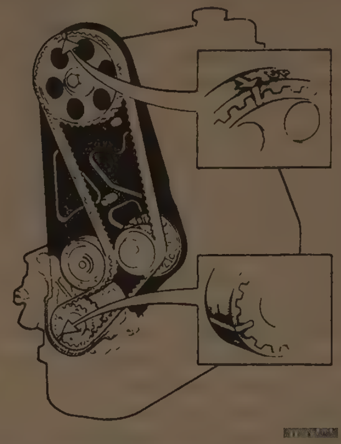


Fig. 161 Mark the timing belt and gears to enable installation in the exact same position

15. Install the lifting equipment or chain hoist on the engine. When securely mounted, raise engine slightly.
16. Loosen the bolts holding the front axle crossmember at both sides.
17. Drain the engine oil. Replace the drain plug when draining is complete.

✲✲CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

18. Remove the swaybar retaining bolts from the side members.
19. Loosen the wiring harness clamp on the right side of the engine, and loosen the clamp holding the battery cable (near the right engine mount).
20. Remove the retaining nuts for the engine mounts. Lower the sidemember and detach the steering column from the joint.
21. Disconnect the oil return line from the oil pan.
22. Remove the retaining bolts for the oil pan. Note that the bolts you remove are different sizes. It is important to record location of each bolt. Proper gasket sealing during reassembly depends on use of the correct bolt. The rear and center bolts are reached through openings in the flywheel. Remove the four bolts from the flywheel casing. Remove the oil pan.
23. With the pan removed, disconnect the oil tube bolts at the oil pump. The tube may manipulated by loosening the bolts which hold it to the block.
24. Remove the bolts remaining in the oil pump and remove the pump. Take care not to damage the pump body.
25. Remove the gaskets for the oil pan and pump. Clean the mating surfaces.
26. When installing the new pump, always use a new gasket. Make sure the pump gear aligns with the crankshaft

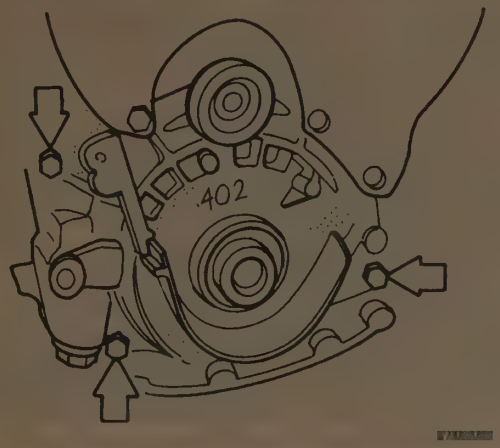


Fig. 162 Location of the oil pump retaining bolts — D24 and D24T engines

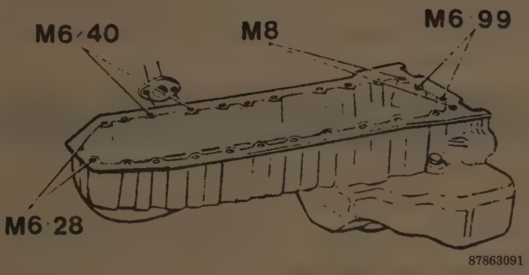


Fig. 163 Record each original diesel oil pan bolt position to enable correct installation of the different size bolts

flange. Secure the pump with three bolts, the longest of which goes in the right-side hole.

27. Connect the oil pump tube. Use a new gasket and tighten to 7 ft. lbs. (9 Nm). Tighten the tube retaining bolts on the block.

28. Install the oil pan with a new gasket. Hold the gasket in place with a light coating of grease. Remember to install the proper size bolt in the proper spot.

29. Using a new gasket, reconnect the oil return line to the pan.

30. Raise the front axle crossmember with a jack and position the steering shaft joint. Guide the engine mounts into position. Loosely attach the crossmember retaining nuts and attach the nuts to the engine mounts. The jack may be removed when the pieces are secured.

31. Reconnect the wiring harness clamp and the clamp for the battery lead.

32. Tighten the mounting bolts for the front crossmember to 60 ft. lbs. (81 Nm). Double check engine mount nuts and relieve tension on the lifting equipment. Disconnect and remove the lifting equipment.

33. Reconnect and secure the steering shaft joint. Reconnect the wire to the oil level transmitter and push in the dipstick.

34. Replace the cover retaining bolts, the idler pulley, and the oil pump seal.

35. Remount the bracket for the cooling fan and alternator.

36. Install the timing belt. Align the marks on the upper and lower gears with the marks on the belt. It is critical that the belt be refitted exactly as it was removed.

37. Draw tension on the belt by moving the water pump by hand. Tighten the water pump mounting bolts.

38. Install the lower timing gear cover and the vibration damper. Note that the damper can only be fitted one way--the pin on the crank gear must fit into the damper. Tighten the four bolts to 15 ft. lbs. (20 Nm). Install the large center nut, using the special tools as before. Tighten the center nut to 255 ft. lbs. (345 Nm).

39. Turn the engine clockwise ¼ turn. Use a belt tension gauge to check the timing belt tension. Adjust the tension by moving the water pump as necessary. If using Volvo tool No. 5197, the correct tension is 12.5 units.

40. Reinstall the front timing gear cover. Install the fan with its spacer and pulley. Tighten the fan bolts to 7 ft. lbs. (9 Nm).

41. Install the belts for the fan and power steering pump. Adjust the belts to the proper tension.

42. Reinstall the radiator. Connect the hoses to the radiator and the hose to the cold start device. Refill the coolant system with a 50-50 mixture of antifreeze and water.

43. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

44. Reconnect the negative battery cable. Start the engine and check for leaks.

45. Disconnect the upper hose to the cold start device. Place a collecting pan or jug beneath the hose and hold the hose level with the top edge of the expansion tank. Allow the engine to come to normal operating temperature with the cap off the expansion tank. Add coolant as necessary as the engine warms up.

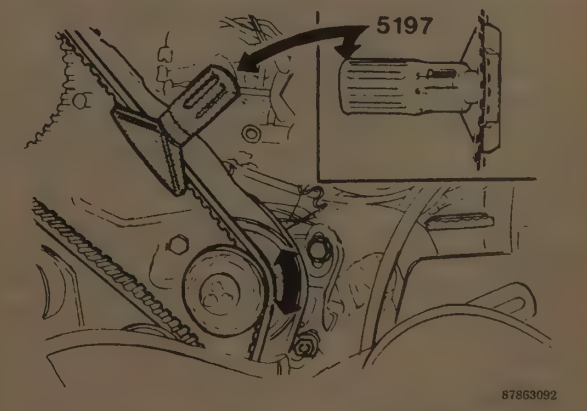


Fig. 164 Move the water pump as necessary to adjust belt tension — D24 and D24T engines with special Volvo tool installed

46. When the coolant level is stable and no air is coming from the disconnected hose, shut the engine off. Reconnect the upper hose to the cold start device, top up the coolant in the expansion tank and put the cap back on the tank.

Timing Gear Cover

REMOVAL & INSTALLATION

B20 Engine

1. Loosen the fan (drive) belt. Remove the fan and water pump pulley. Disconnect the stabilizer attachment from the frame.
2. Remove the crankshaft pulley and bolt.
3. Remove the retaining bolts and the timing gear cover. Loosen a few oil pan bolts, being careful not to damage the pan gasket.
4. Remove the circlip, washer, and felt ring from the cover. Replace any gasket in questionable condition. Make sure that the oil drain hole is open and clean.
5. Place the cover in position and install the retaining bolts finger-tight.
6. Center the cover with a sleeve. Turn the sleeve while tightening and adjust the position of the cover so that the sleeve may be easily rotated without jamming.
7. Install a new felt ring, washer, and circlip. Push them into their positions with the engaging sleeve. Check to make sure that the circlip has seated in its groove.
8. Tighten the cover bolts. Install the pulleys and fan. Tension the accessory drive belts. Tighten the stabilizer attachment firmly to the frame.

Timing Gear Cover Oil Seal

REPLACEMENT

B20 Engine

1. Remove the fan belt. Loosen the stabilizer attachment at the frame.
2. Remove the crankshaft pulley and bolt.
3. Remove the circlip for the washer retaining the felt ring. Check to make sure that the cover is correctly installed by inserting a 0.004 in. (0.10mm) feeler gauge between the casing and the crankshaft hub. If the feeler gauge jams at any point, the cover must be centered.
4. Install a new felt ring. Place the washer in position and install the circlip in its groove.
5. Install the crankshaft pulley and fan. Tension the fan (drive) belt. Tighten the stabilizer attachment at the frame.

B30 Engine

➧ See Figure 165

1. Drain the cooling system by opening the engine drain plug and disconnecting the lower radiator hose. On automatic transmission cars, disconnect and plug the transmission oil cooler lines at the radiator. Remove the radiator, fan shroud, and grille.
2. Remove the fan (drive) belt. Remove the bolts for the pulley and crankshaft damper.
3. Remove the center bolt and pull off the hub by hand or, if necessary, with a puller.
4. Remove the oil seal. Lubricate the sealing lip on the new seal and install the seal with a drift. The seal may be installed in one of three positions, depending on the amount of wear on the hub. With a new hub, the seal will be installed in its outer position (position 1). With a wear mark on the hub, install the seal in position 2. With two wear marks on the hub, install the seal in position 3. With three wear marks on the hub, you have either a very old engine or you have gone through more than a normal share of oil seals. It's time to think about replacing the old hub with a new one.
5. Grease the sliding surfaces of the hub and install the hub. Note the center punch marks on the crankshaft end and hub. Install the center bolt and torque it to 50-57 ft. lbs. (68-77 Nm).
6. Install the crankshaft damper and pulley.
7. Install and properly tension the fan (drive) belt. Install the radiator, fan shroud, and grille. Install the lower radiator hose, close the drain plug, and fill the cooling system. On cars with automatic transmissions, connect the transmission oil cooler lines at the radiator.

Timing Belt Cover

REMOVAL & INSTALLATION

B21, B23 and B230 Engines

➧ See Figures 166 and 167

1. Loosen the fan shroud and remove the fan. Remove the shroud.
2. Loosen the alternator, air pump, power steering pump (if so equipped), and AC compressor (if so equipped) and remove their drive belts. Note that no hoses are to be disconnected; simply move the entire unit out of the way.

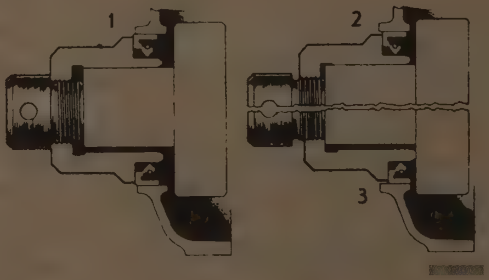


Fig. 165 Remove the crankshaft hub by hand or with a puller to service the timing gear oil seal

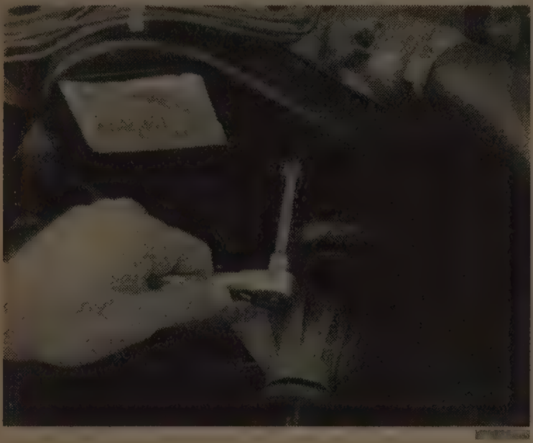


Fig. 166 With the necessary belts removed, remove the retaining bolts to the timing belt cover

3. Remove the water pump pulley. This step is not necessary on B234 engines.
4. Remove the four retaining bolts and lift off the timing belt cover. On the B234, the timing belt cover is in three sections; remove the upper section first and work to the lowest one.
5. Reverse the above procedure to install. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

D24 and D24T Diesel Engines

FRONT TIMING GEAR COVER

◆ **See Figure 168**

The front timing gear cover is removed by unsnapping the spring clips holding the cover and pulling the cover up and out. To install the cover, simply reverse the procedure.

Fig. 167 Once detached, pull away and set aside the upper cover in a safe location

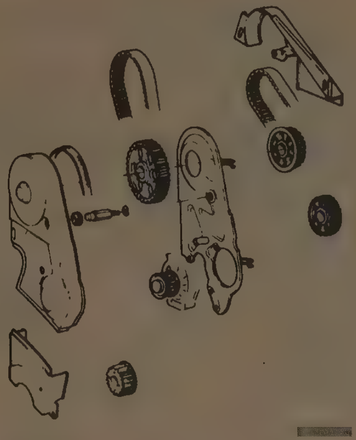


Fig. 168 Exploded view of the timing belt cover and assembly — D24 engines

REAR TIMING GEAR COVER

To remove the rear timing gear cover, remove the two bolts in the cover and lift the cover out. When installing, adjust the cover in the bolt slots so that it is not touching the drive belt or other moving parts.

Timing Chain Cover

REMOVAL & INSTALLATION

B27F, B28F and B280F Engines

1. Disconnect the negative battery cable.
2. Drain the coolant by opening the drain cock on the left side of the engine. A radiator hose may also be disconnected to speed draining.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. After removing any electrical leads to the radiator, disconnect the oil cooler lines to the radiator on cars with automatic transmissions. Remove the fan shroud from the radiator, disconnect the hoses and remove the radiator. Remove the fan shroud.
4. Remove the splash shield under the engine. Loosen the alternator and power steering belts.
5. Remove the power steering pump from its bracket and secure it with wire out of the way. Do not disconnect any lines or hoses. After the pump is moved and secure, remove the bracket from the engine.
6. Detach and secure to one side the air conditioning compressor, if so equipped. Don't disconnect any lines or hoses.

7. Remove the fan, fan pulley and drive belts.

8. After removing the air intake duct and the vacuum pump, remove the left valve cover.

9. Using a 5mm Allen wrench, remove the fuel pressure regulator and lay it on the intake manifold. Disconnect the main ignition wire (near the right side shock tower) and remove the oil filler cap. Remove the right valve cover.

10. Turn the crankshaft to the overlap position on cylinder No. 1. This means the rocker arms for cylinder No. 1 do NOT have clearance and the first mark on the crank pulley is aligned with the "0" mark on the pointer.

11. Using either Volvo special tool No. 5112 or an acceptable substitute, lock the flywheel in position so that the engine cannot be moved out of position.

12. By using a 36mm socket, remove the crankshaft pulley. Take care that the small locking (Woodruff) key on the crankshaft does not fall into the lower part of the engine.

13. Move the wiring harness on the timing cover to one side and remove the timing cover.

14. Using a plastic (not metal) scraper, clean the gasket surfaces on the timing cover, the valve covers, and the front of the engine block.

15. Tap the center seal out of the timing cover and replace it with a new one.

16. Install the timing gear cover with a new gasket. Apply a light coat of locking fluid to the four lower bolts; tighten all the bolts to 10-11 ft. lbs. (14-15 Nm).

17. Install the crankshaft pulley. Tighten to 190-200 ft. lbs. (258-271 Nm).

18. Remove the locking device from the flywheel.

19. Apply new gaskets and reinstall both valve covers.

20. On the right side of the motor, replace the oil filler cap, the ignition lead and the fuel control pressure regulator.

21. Close the drain cock on the left side of the engine.

22. On the left side of the motor, reconnect the vacuum pump (with a new gasket) and the air inlet duct.

23. Reinstall the fan, pulley, and drive belts. Replace the bracket and the power steering pump with its belt. Adjust all the belts to the correct tension.

24. Install the air conditioning compressor and set the belt tension.

25. Install the fan shroud and the radiator. Connect the oil cooler lines to the radiator (cars with automatic transmission), and connect all the hoses to the radiator. Reconnect any wiring to sensors on the radiator.

26. Install the splash guard under the car.

27. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

28. Reconnect the battery cable. Fill the cooling system with a 50-50 mixture of coolant and water. Start the engine and check for leaks. After the engine has fully warmed up, check the coolant level and top up as needed.

Timing Belt

REMOVAL & INSTALLATION

B21, B23 and B230 Engines

➧ See Figures 169, 170, 171, 172, 173 and 174

1. Remove the timing belt cover as outlined previously.

2. To remove the tension from the belt, loosen the nut for the tensioner and press the idler roller back. The tension spring can be locked in this position by inserting the shank end of a $^{3}/_{32}$ (3mm) drill bit through the pusher rod.

3. Remove the six retaining bolts and the crankshaft pulley.

4. Remove the belt, taking care not to bend it at any sharp angles. The belt should be replaced routinely at 45,000 mile intervals, or anytime it becomes oil soaked or frayed.

5. If the crankshaft, idler shaft, or camshaft were disturbed while the belt was off, align each shaft with its corresponding

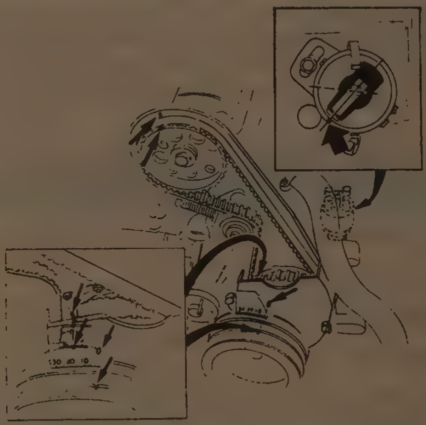


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Fig. 169 Align the crankshaft and camshaft marks prior to removing the timing belt — B230F engines

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Fig. 170 View of the timing belt prior to removal — B21FT engine

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Fig. 171 If you need the room, the fuel injector lines may be moved aside by unbolting their hold-down clamp

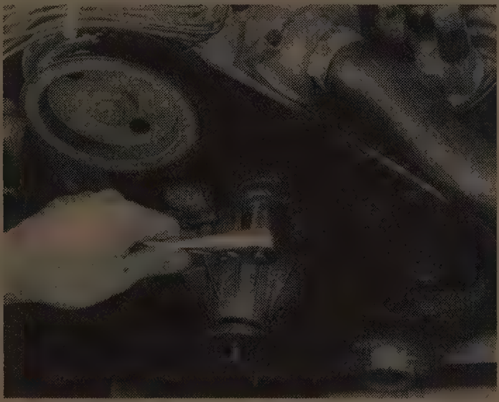
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Fig. 172 Loosen the tensioner — you may hold the tensioner in place by inserting a 3/32 in. (3mm) dowel pin or drill bit in the pusher rod

87863351

Fig. 173 Remove the timing belt once tension is released

87863352

Fig. 174 This belt is ready for the trash — replace the belt if damaged or if it is near the end of its recommended life

index mark (to assure proper valve timing and ignition timing) as follows:

a. Rotate the crankshaft so that the notch in the crankshaft gear belt guide aligns with the embossed mark on the front cover (12 o'clock position).

b. Rotate the idler shaft so that the dot on the idler shaft drive sprocket aligns with the notch on the timing belt rear cover (four o'clock position).

c. Rotate the camshaft so that the notch in the camshaft sprocket inner belt guide aligns with the notch in the forward edge of the valve cover (12 o'clock position).

6. Install the timing belt (don't use any sharp tools) over the sprockets, and then over the tensioner roller. Loosen the tensioner nut and let the spring tension automatically take up the slack. Tighten the tensioner nut to 37 ft. lbs. (50 Nm).

7. Rotate the crankshaft one full revolution clockwise, and make sure the timing marks still align.

8. Reverse Steps 1-3 to install.

B234 Engine

➡The B234 engine has two belts, one driving the camshafts and one driving the balance shafts. The camshaft belt may be removed separately; the balance shaft belt requires removal of the cam belt. During reassembly, the EXACT placement of the belts and pulleys must be observed.

1. Remove the negative battery cable and the alternator belt.
2. Remove the radiator fan, its pulley and the fan shroud.
3. Remove the drive belts for the power steering belts and the air conditioning compressor.
4. Beginning with the top cover, remove the retaining bolts and remove the timing belt covers.
5. Turn the engine to TDC on cylinder 1. Make sure the marks on the cam pulleys align with the marks on the backing plate and that the marking on the belt guide plate (on the crankshaft) is opposite the TDC mark on the engine block.
6. Remove the protective cap over the timing belt tensioner locknut. Loosen the lock nut, compress the tensioner (so as to release tension on the belts) and retighten the locknut, holding the tensioner in place.

7. Remove the timing belt from the camshafts. Do not crease or fold the belt.

WARNING

The camshafts and the crankshaft MUST NOT be moved when the belt is removed!

8. Check the tensioner by spinning it (counterclockwise) and listening for any bearing noise within. Check also that the belt contact surface is clean and smooth. In the same fashion, check the timing belt idler pulleys. Make sure the are tightened to 18.5 ft. lbs. (25 Nm). If the balance shaft belt is to be removed:

a. Remove the balance shaft belt idler pulley from the engine.

b. Loosen the locknut on the tensioner and remove the belt. Slide the belt under the crankshaft pulley assembly. Check the tensioner and idler wheels carefully for any sign of contamination; check the ends of the shafts for any sign of oil leakage.

c. Check the position of the balance shafts and the crankshaft after belt removal. The balance shaft markings on the pulleys should align with the markings on the backing plate and the crankshaft marking should still be aligned with the TDC mark on the engine block.

d. When refitting the balance shaft belt, observe that the belt has colored dots on it. These marks assist in the critical placement of the belt. The yellow dot will align the right (lower) shaft, the blue dot will align on the crank and the other yellow dot will match to the upper (left) balance shaft.

e. Carefully work the belt in under the crankshaft pulley. Make sure the blue dot is opposite the bottom (TDC) marking on the belt guide plate at the bottom of the crankshaft. Fit the belt around the left (upper) balance shaft pulley, making sure the yellow mark is opposite the mark on the pulley. Install the belt around the right (lower) balance shaft pulley and again check that the mark on the belt aligns with the mark on the pulley.

f. Work the belt around the tensioner. Double check that all the markings are still aligned.

g. Set the belt tension by inserting an Allen key into the adjusting hole in the tensioner. Turn the crankshaft carefully through a few degrees on either side of TDC to check that the belt has properly engaged the pulleys. Return the crank to the TDC position and set the adjusting hole just below the 3 o'clock position when tightening the adjusting bolt. Use the Allen wrench (in the adjusting hole) as a counter hold and tighten the locking bolt to 30 ft. lbs. (40 Nm).

h. Use Volvo tool 998 8500 to check the tension of the belt. Install the gauge over the position of the removed idler pulley. The tension must be 1-4 units on the scale or the belt must be readjusted.

9. Reinstall the camshaft belt by aligning the double line marking on the belt with the top marking on the belt guide plate at the top of the crankshaft. Stretch the belt around the crank pulley and place it over the tensioner and the right side idler. Place the belt on the camshaft pulleys. The single line marks on the belt should align exactly with the pulley markings. Route the belt around the oil pump drive pulley and press the belt onto the left side idler.

10. Check that all the markings align and that the engine is still positioned at TDC for cylinder 1.

11. Loosen the tensioner locknut.

12. Turn the crankshaft clockwise. The cam pulleys should rotate one full turn until the marks again align with the marks on the backing plate.

WARNING

The engine must not be rotated counterclockwise during this procedure.

13. Smoothly rotate the crankshaft further clockwise until the cam pulley markings are 1½ teeth beyond the marks on the backing plate. Tighten the tensioner locknut.

14. Check the tension on the balance shaft belt; it should now be 3.8 units on the scale. If the tension is too low, adjust the tensioner clockwise. If the tension is too high, repeat Step 8g above.

15. Check the belt guide for the balance shaft belt and make sure it is properly seated. Install the center timing belt cover (the one that covers the tensioner) the fan shroud, fan pulley and fan. Install all the drive belts and connect the battery cable.

16. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

17. Start the engine and allow it to run until the thermostat opens.

CAUTION

The upper and lower timing belt covers are still removed. The belt and pulleys are exposed and moving at high speed.

18. Shut the motor off and bring the motor to TDC on cylinder No. 1.

19. Check the tension of the camshaft belt. Position the gauge between the right (exhaust) cam pulley and the idler. Belt tension must be 5.3-5.7 units on the scale. If the belt needs adjustment, remove the rubber cap over the tensioner locknut (cap is located on the timing belt cover) and loosen the locknut.

a. Insert a prytool between the tensioner wheel and the spring carrier pin to hold the tensioner. If the belt needs to be tightened, move the roller to adjust the tension to 6.0 units on the scale. If the belt is too tight, adjust to obtain a reading of 5.0 units on the gauge. Tighten the tensioner locknut.

b. Rotate the crankshaft so that the cam pulleys move through one full revolution and recheck the tension on the camshaft belt. It should now be 5.3-5.7 units on the scale. Install the plastic plug over the tensioner bolt.

c. Final check the tension on the balance shaft belt by fitting the gauge and turning the tensioner clockwise. Only small movements are needed. After any needed readjustments, rotate the crankshaft clockwise through one full revolution and recheck the balance shaft belt. The tension should now be on the final specification of 4.7-5.1 units.

d. Install the idler pulley for the balance shaft belt. Reinstall the upper and lower timing belt covers.

20. Start the engine and final check performance.

D24 and D24T Diesel Engines

➧ **See Figure 175**

When replacing both the front and rear camshaft belts at the recommended 75,000 mile (120,773 km) interval, you must also replace the front idler pulley.

➡Due to the number of special tools needed to perform this operation, it is recommended that timing belt removal and installation be performed by a competent garage. However, if you have access to the required special tools, the procedure is given below.

1. Disconnect the negative battery cable.
2. Drain the coolant and remove the splash guard from under the engine.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Disconnect the lower radiator hose and remove the expansion tank cap.
4. Remove the radiator, the cooling fan with spacer and pulley, the fan belt and the drive belt for power steering pump.
5. Remove the valve cover and the front and rear timing belt covers.
6. Set No. 1 cylinder on top dead center of its compression stroke and align the flywheel timing mark at 0.
7. Using special wrench 5187 to hold the vibration damper, remove the damper center bolt with wrench 5188. It may be necessary to turn the engine slightly to permit wrench 5187 to rest on the cooling fan journal. After the center bolt is removed, use wrench 5187 to put No. 1 cylinder on TDC again.
8. Remove the four bolts and remove the vibration damper. You may have to tap it to free it from the crankshaft gear.
9. Remove the lower timing belt shield, release the retaining bolts for the coolant pump and loosen and remove the belt.
10. Remove the idler pulley center bolt and remove the idler pulley using puller 5202. Tap a new idler pulley into place and install its center bolt.
11. Use wrench 5199 to hold the rear gear and use wrench 5201 to remove its center bolt. Remove the rear camshaft gear and remove the cover gasket.
12. Install gauge 5190 in the groove on the camshaft rear end to lock the camshaft in position. Position a 0.008 in. (0.2mm) feeler blade under the left side of the gauge to compensate for clearances in the timing gears.
13. Remove the front camshaft gear bolt using tool No. 5199 to hold the gear in position. Do not allow the camshaft to turn. Tap the gear loose.

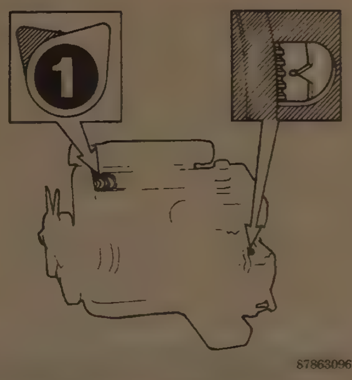


Fig. 175 Set the diesel No.1 cylinder to TDC — note position of the cam lobes and flywheel pointer

14. After checking to make sure that the flywheel mark is still at 0 and that the camshaft has not moved, install the new belt and the camshaft front gear. Make sure the belt fits securely on the gears. Install the center bolt on the camshaft front gear finger-tight. The camshaft gear must be able to rotate by itself. The camshaft must not be rotated.
15. Install the lower belt shield and vibration damper. The damper fits only one way. Tighten the damper attaching bolts to 15 ft. lbs. (20 Nm).
16. Install the crankshaft center bolt after applying sealer to the threads and contact surfaces. Use wrench 5187 to hold the vibration damper. It can rest on the cooling fan journal. Use wrench 5188 to tighten the center bolt to 255 ft. lbs. (345 Nm).

➡This torque applies only if tool No. 5188 is used. If only a torque wrench is used, tighten to 330 ft. lbs. (447 Nm).

17. Verify that No. 1 cylinder is still at TDC.
18. Using the cooling pump movement, adjust the belt tension. Install belt tension gauge 5197 on the belt. Set the gauge to 12.5. Adjust belt tension with the water pump until the mark on the plunger is flush with the gauge sleeve.
19. Press heavily on the belt with your hand and once again check the belt tension. Adjust if necessary.
20. Using wrench 5199 to hold the gear, tighten the front gear center bolt to 33 ft. lbs. (45 Nm).Make sure the camshaft does not rotate.
21. Remove the feeler gauge and the lock gauge at the rear of the engine.
22. Set the injection pump timing as instructed in Section 5.
23. Reinstall the front and rear timing gear covers. Reinstall the valve cover.
24. Install the fan with its spacer and pulley. Tighten the fan bolts to 7 ft. lbs. (9 Nm).
25. Install the belts for the fan and power steering pump. Adjust the belts to the proper tension.
26. Reinstall the radiator. Connect the hoses to the radiator and the hose to the cold start device. Refill the coolant system with a 50-50 mixture of antifreeze and water.
27. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor rout-

ing of hoses and wires (too tight or rubbing) and tools left in the engine area.

28. Reconnect the negative battery cable. Start the engine and check for leaks.

29. Disconnect the upper hose to the cold start device. Place a collecting pan or jug beneath the hose and hold the hose level with the top edge of the expansion tank. Allow the engine to come to normal operating temperature with the cap off the expansion tank. Add coolant as necessary as the engine warms up.

30. When the coolant level is stable and no air is coming from the disconnected hose, shut the engine off. Reconnect the upper hose to the cold start device, top up the coolant in the expansion tank and put the cap back on the tank.

Timing Chain

REMOVAL & INSTALLATION

B27F, B28F, and B280F Engines

▶ See Figure 176

1. Remove the timing chain cover as outlined previously.
2. Remove the oil pump sprocket and drive chain.
3. Loosen the tension in both camshaft timing chains by rotating each tensioner lock ¼ turn counterclockwise and pushing in the rubbing block piston.
4. Remove both chain tensioners. Remove the two curved and the two straight chain damper/runners.
5. Remove the camshaft sprocket retaining bolt (10mm Allen head) and the sprocket and chain assembly. Repeat for other side.

To install:

6. Install the chain tensioners and tighten to 5 ft. lbs. (7 Nm). Install the curved chain damper/runners and tighten to 7-11 ft. lbs. (9-15 Nm). Install the straight chain damper/runners and tighten to 60 inch lbs. (81 Nm).
7. Install the left side camshaft sprocket and chain first. Rotate the crankshaft (use crankshaft nut, if necessary) until no. 1 cylinder is at TDC. (At this point, the crankshaft key is pointing directly to the left side camshaft and the left side camshaft key groove is pointing straight up.)
8. Place the chain on the left side sprocket so that the camshaft sprocket notchmark is centered precisely between the two white lines on the chain.
9. Position the chain on the inner crankshaft sprocket, making sure that the other white line on the chain aligns with the crankshaft sprocket notch.
10. While holding the left side chain and sprockets in this position, install the sprocket and chain on the left side camshaft (chain stretched on tension side) so that the sprocket pin fits into the camshaft recess.
11. Tighten the sprocket center bolt to 51-59 ft. lbs. (69-80 Nm). Use a prytool to keep the cam from turning.
12. To install the right side camshaft sprocket and chain, rotate the crankshaft clockwise until the crankshaft key points straight down.
13. Align the camshaft key groove so that it is pointing in the position shown; at this position, the no. 6 cylinder rocker arms will rock.
14. Place the chain on the right side sprocket so that the sprocket notchmark is centered precisely between the two white lines on the chain.
15. Position the chain on the middle crankshaft sprocket, making sure that the other white line aligns with the crankshaft sprocket notch.
16. Install the sprocket and chain on the camshaft so that the sprocket notch fits into the camshaft recess. Tighten the sprocket nut to 51-59 ft. lbs. (69-80 Nm).
17. Rotate each of the chain tensioners ¼ turn clockwise. The chains are tensioned by rotating the crankshaft two full turns clockwise. Recheck to make sure the alignment marks coincide.
18. Install the oil pump sprocket and chain.
19. Install the timing chain cover and engine accessories as outlined previously.

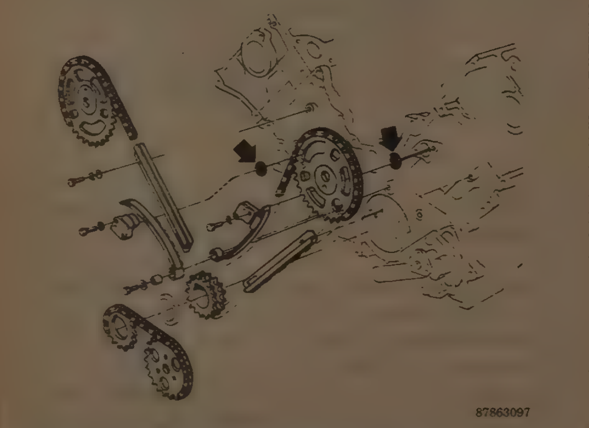


Fig. 176 Exploded view of the timing chain arrangement. The arrows point to oil screens which should be cleaned — B28 and B280 engines

Timing Gear and Camshaft

REMOVAL & INSTALLATION

B20 and B30 Engines

1. Disconnect the lower radiator hose, open the engine drain plug, and drain the cooling system. On cars with automatic transmissions, disconnect the plug the transmission oil cooler lines at the radiator. Remove the fan shroud and the radiator.
2. Remove the fan and the pulley on the water pump. Remove the crankshaft bolt and remove the pulley using a puller.
3. Remove the timing gear cover. Loosen a few oil pan bolts, being careful not to damage the pan gasket.
4. Measure the tooth flank clearance. Maximum permissible gear backlash is 0.005 in. (0.13mm). Check to make sure that the end-play of the camshaft does not exceed 0.002 in. (0.05mm). Camshaft end-play is determined by the shim behind the camshaft timing gear.
5. Try to align the marks on the timing gears dot to dot (or line to dot) prior to removing the gears. If this is not possible,

note the correct relative position of the timing gear marks. Remove the hub from the crankshaft with a puller. Remove the crankshaft gear and the camshaft gear with a puller. Remove the oil jet, blow it clean, and reposition it. Oil fed through this jet lubricates the timing gears.

6. If the camshaft is being replaced, it is necessary to remove the distributor (noting its position), the distributor/oil pump driveshaft, fuel pump, valve cover, rocker shaft and arm assembly, pushrods, cylinder head, valve lifters, and the thrust flange. The camshaft may then be pulled out the front.

To install:

7. Reverse the above procedure to install. Replace the camshaft if the lobes exhibit excessive or uneven wear. Install the crankshaft and camshaft timing gears, making sure that they align in the correct relative positions. Do not push the camshaft backward, or the seal washer on the rear end may be forced out. Recheck the tooth flank clearance and the camshaft end-play.

8. Bring no.1 piston to TDC. Install the distributor/oil pump driveshaft so that the offset position of the distributor slot (angle A) is 35° for the B30A and B30F engines, and 5° for the B20B, B20E and B20F engines.

➡Make sure that the distributor/oil pump driveshaft seats fully in the slot at the top of the oil pump. If necessary, use a long prytool to turn the pump manually until the slot aligns.

9. When installing the timing case cover, make sure that the drain holes are open. Center the cover with a sleeve. Install the distributor, making sure the rotor points to the no. 1 cylinder position.

10. Install the pulleys and fan. Install the fan (drive) belt and adjust the tension. Refit the radiator hose, close the drain plug, and fill the cooling system.

11. Adjust the ignition timing.

B21, B23 and B230 Engines

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure.

1. Remove the timing belt cover and timing belt as outlined in their appropriate sections.
2. Remove the valve cover.
3. Remove the camshaft center bearing cap. Install special camshaft press tool (Volvo #5021) over the center bearing journal to hold the camshaft in place while removing the other bearing caps.
4. Remove the four remaining bearings caps.
5. Remove the seal from the forward edge of the camshaft.
6. Release camshaft press tool, and lift out the camshaft.
7. Reverse the above procedure to install. The camshaft press tool must be used during reassembly.

B27F, B28F and B280F Engines

1. Remove the cylinder head as outlined previously.
2. Remove the camshaft rear cover plate.
3. Remove the camshaft retaining fork at the front of the cylinder head.
4. Pull the camshaft out the rear of the head.
5. Reverse the above to install. Tighten the front retaining bolt to 7-11 ft. lbs. (7-15 Nm) and the rear cover bolts to 3.7-5.5 ft. lbs. (5-7.5 Nm).

D24 and D24T Diesel Engines

➧ See Figure 177

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure.

1. Remove the front and rear timing covers as outlined above. Remove the valve cover.
2. Set No. 1 cylinder on TDC compression stroke. Verify that the flywheel 0 mark is aligned with the pointer on the bell housing. Remove the expansion tank cap.
3. Remove the front camshaft gear belt by loosening the cooling pump retaining bolts to release belt tension. Tighten the two lower retaining bolts to avoid coolant loss. Work the belt off the camshaft gear.
4. Using special wrench No. 5199 or an equivalent tool, hold the camshaft front timing gear in place and remove the center bolt. Do not allow the camshaft to turn or you may bend several valves.
5. Release the belt shield from the front of the camshaft. If necessary, loosen the upper retaining bolts for the coolant pump. Pull the shield out from the camshaft and hold it in this position by jamming a piece of wood between it and the engine.
6. Remove the rear timing belt by loosening the retaining bolts for the injection pump bracket to release belt tension. Slide the belt off the rear timing gear and tighten one of the injection pump mount bolts so that the pump remains in the upper position.
7. Remove the rear gear from the camshaft using wrench No. 5199 to hold the camshaft from turning. Using wrench No. 5201 or an appropriate substitute, remove the center bolt and the gear.
8. Remove the vacuum pump and its plunger.
9. Remove camshaft bearing caps 1 and 4.
10. Remove camshaft bearing caps 2 and 3. Lift out the camshaft and remove the seals.

To install:

11. Oil the bearing surfaces and install the camshaft in the head. Install gauge No. 5190 on the camshaft rear end to position the camshaft on the cylinder head. When the camshaft is correctly installed, both cam lobes on No. 1 cylinder should point up at equally large angles.
12. Install camshaft bearing caps 2 and 3. Take note to correctly install the caps, as their centers are staggered. The caps are marked: do not interchange them.
13. Tighten the bearing cap nuts alternately to avoid uneven loadings on the camshaft.
14. Remove gauge No. 5190. Install new oil seals but do not bottom them in their holders.
15. Install camshaft bearing caps 1 and 4. Fit bearing cap 4 against the thrust bearing.
16. Torque all cap nuts to 15 ft. lbs. (20 Nm). Press the oil seals into final position. Use special tool No. 5200 and the center bolt to install the rear seal, and use tool No. 5200 and a hammer to tap the front seal into position.
17. Install gauge No. 5190 in the groove on the camshaft rear end to lock the camshaft in position. Position a 0.008 in. (0.2mm) feeler blade under the left side of the gauge to compensate for clearances in the timing gears.
18. After checking to make sure that the flywheel mark is still at 0 and that the camshaft has not moved, install the new

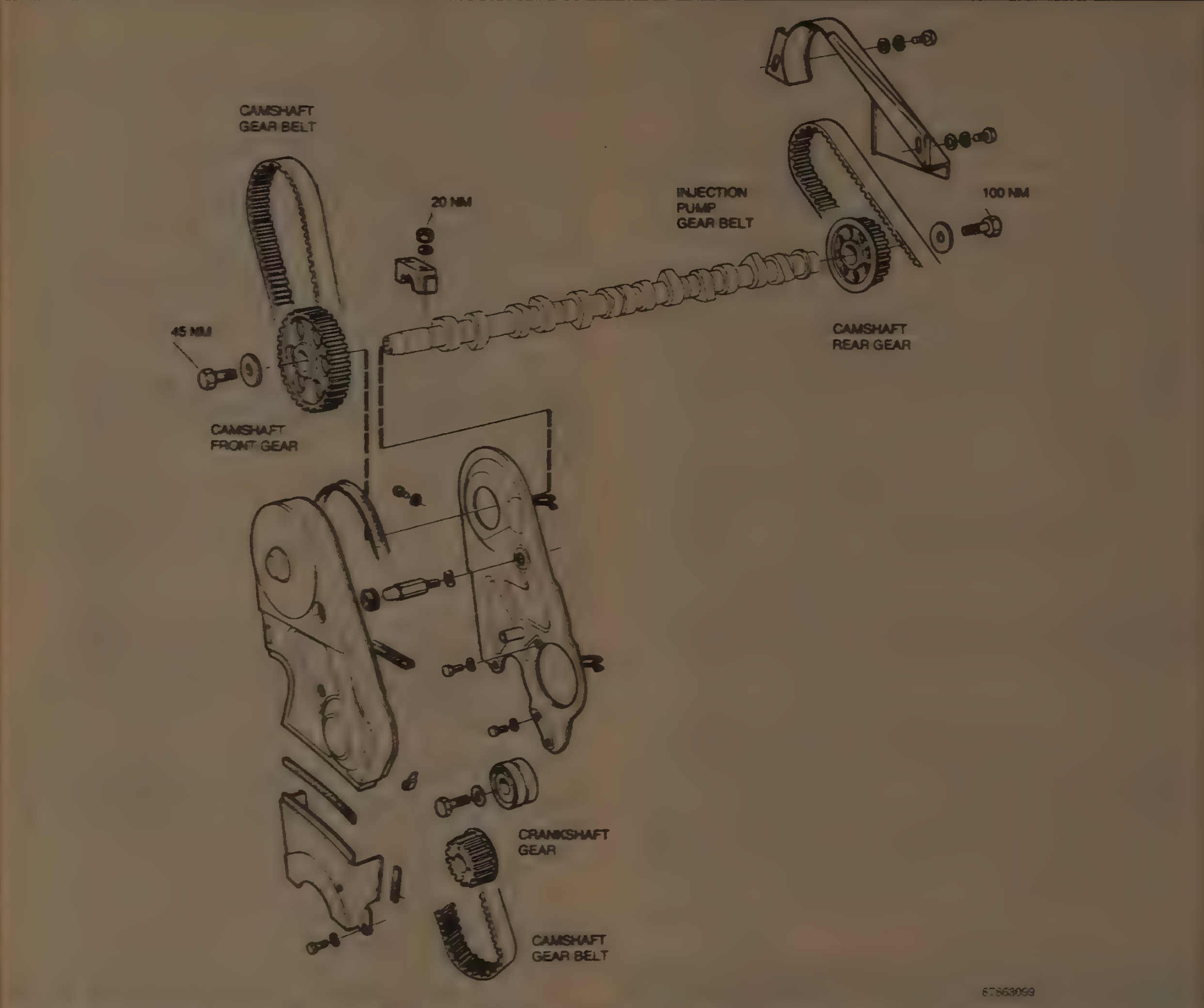


Fig. 177 Exploded view of the camshaft and timing gear assembly — D24 and D24T

belt and the camshaft front gear. Make sure the belt fits securely on the gears. Install the center bolt on the camshaft front gear finger-tight. The camshaft gear must be able to rotate by itself. The camshaft must not be rotated.

19. Install the lower belt shield and vibration damper. The damper fits only one way. Tighten the damper attaching bolts to 15 ft. lbs. (20 Nm).

20. Install the crankshaft center bolt after applying sealer to the threads and contact surfaces. Use wrench 5187 to hold the vibration damper. It can rest on the cooling fan journal. Use wrench 5188 to tighten the center bolt to 255 ft. lbs. (345 Nm).

➡This torque applies only if tool No. 5188 is used. If only a torque wrench is used, tighten to 330 ft. lbs. (447 Nm).

21. Verify that No. 1 cylinder is still at TDC.

22. Using the cooling pump movement, adjust the belt tension. Install belt tension gauge 5197 on the belt. Set the gauge to 12.5. Adjust belt tension with the water pump until the mark on the plunger is flush with the gauge sleeve.

23. Press heavily on the belt with your hand and once again check the belt tension. Adjust if necessary.

24. Using wrench 5199 to hold the gear, tighten the front gear center bolt to 33 ft. lbs. (45 Nm). Make sure the camshaft does not rotate.

25. Remove the feeler gauge and the lock gauge at the rear of the engine.

26. Set the injection pump timing as instructed in Section 5.

27. Reinstall the front and rear timing gear covers. Reinstall the valve cover.

B234 Engine

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure.

1. Disconnect the negative battery cable.

2. Remove the alternator drive belt, the radiator fan and its pulley.

3. Remove the upper and lower timing belt covers.

4. Align the camshaft and crankshaft marks. Turn the engine to TDC on cylinder 1 and make sure the pulley marks

and the crank marks align align with their matching marks on either the backing plate (cam pulleys) or the belt guide plate (crankshaft).

5. Remove the protective cap over the timing belt tensioner locknut. Loosen the lock nut, compress the tensioner (so as to release tension on the belts) and retighten the locknut, holding the tensioner in place.

6. Remove the timing belt from the camshafts. Do not crease or fold the belt.

✻✻WARNING

The camshafts and the crankshaft MUST NOT be moved when the belt is removed.

7. Remove the timing belt idler pulleys.

8. Remove the camshaft drive pulleys. Use a counterhold wrench to prevent the cam from turning.

9. Remove the plate or panel behind the pulleys. Remove the cover plate for the ignition wires. Label and disconnect the ignition wiring from the spark plugs and the distributor cap; remove the coil wire from the distributor cap.

10. Remove the valve cover and gasket. Clean the surfaces of any gasket remains.

11. Remove the distributor housing from the camshaft carrier. Remove the ignition wire clip next to the left bolt.

12. Plug the spark plug holes with crumpled paper. Remove the center bearing cap for each camshaft. Mark the cam bearing caps for proper reinstallation.

13. Install a camshaft press tool, such as Volvo tool No. 5021 or similar on the exhaust side cam in place of the removed bearing cap. When it is securely in place, remove the remaining bearing caps and nuts. Remove the tool and remove the exhaust camshaft.

14. Remove the intake camshaft in identical fashion.

➡Label or identify each cam and its bearing caps. All removed components should be kept in neat order.

15. Using a magnet or a small suction cup, remove the tappets. Store them upside down (to prevent oil drainage) and keep them in order--they are not interchangeable!

16. Clean and inspect the camshaft carrier and tappet bores for any sign of wear or scoring.

To install:

17. Oil all matching surfaces on the cam carrier, bearing caps and tappets.

18. Insert the tappets; they MUST be inserted in their original order and place.

19. Install the exhaust side camshaft by placing it it in the carrier with the pulley guide pin facing up. Using the rear bearing cap as a guide, press the cam into place with the press tool. Install the bearing caps in the original order.

20. Install the bearing cap nuts and tighten them in stages to 15 ft. lbs. (20 Nm). Remove the press tool and install the center bearing cap; tighten it in stages to 15 ft. lbs. (20 Nm).

21. Install the intake camshaft in the carrier with the pulley guide pin facing upwards.

22. Turn the distributor shaft to align the driver with the markings on the distributor housing. Install new O-rings on the housing and rotor shaft.

23. Using the rear bearing cap as a guide, press the cam into place with the press tool. Install the bearing caps in the original order.

24. Install the bearing cap nuts and tighten them in stages to 15 ft. lbs. (20 Nm).

25. Double check the tightness of all the camshaft bearing cap nuts. All should be 15 ft. lbs. (20 Nm). Do not overtighten.

26. Reinstall the distributor, connect the coil wire and install the ignition wire clip at the left bolt. Remove the paper plugs from the spark plug holes.

27. Use a silicone sealer and apply to the front and rear camshaft bearing caps. Install new gaskets for the valve cover and the spark plug wells. Install the spark plug gasket with the arrow pointing towards the front of the car and the word UP facing up. Make sure the valve cover gasket is correctly positioned and install the valve cover.

28. Reconnect the ground wire at the distributor.

29. Install the ignition wires and the cover plate.

30. Using a compression seal driver (Volvo tool No. 5025 or similar), install the oil seals for the front of each camshaft. Camshafts MUST NOT be allowed to turn during this operation.

31. Install the upper backing plate over the ends of the camshafts and adjust the plate so that the cams are centered in the holes.

32. Replace the idler pulleys and tighten their mounts to 18.5 ft. lbs. (25 Nm).

33. Install the camshaft drive pulleys, using a counterhold to prevent the cams from turning.

34. Reinstall the camshaft belt by aligning the double line marking on the belt with the top marking on the belt guide plate at the top of the crankshaft. Stretch the belt around the crank pulley and place it over the tensioner and the right side idler. Place the belt on the camshaft pulleys. The single line marks on the belt should align exactly with the pulley markings. Route the belt around the oil pump drive pulley and press the belt onto the left side idler.

35. Check that all the markings align and that the engine is still positioned at TDC for cylinder 1.

36. Loosen the tensioner locknut.

37. Turn the crankshaft clockwise. The cam pulleys should rotate one full turn until the marks again align with the marks on the backing plate.

✻✻WARNING

The engine must not be rotated counterclockwise during this procedure.

38. Smoothly rotate the crankshaft further clockwise until the cam pulley markings are 1½ teeth beyond the marks on the backing plate. Tighten the tensioner locknut.

39. Reinstall the fan pulley and fan. Install all the drive belts and connect the battery cable.

40. Double check all installation items, paying particular attention to loose hoses or hanging wires, loose nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the engine area.

41. Start the engine and allow it to run until the thermostat opens.

✱✱CAUTION

The upper and lower timing belt covers are still removed. The belt and pulleys are exposed and moving at high speed!

➡This engine may be somewhat noisy when started. The noise will subside as oil reaches the tappets. Do not exceed 2500 rpm while the tappets are noisy.

42. Shut the motor off and bring the motor to TDC on cylinder 1.
43. Check the tension of the camshaft belt. Position the gauge between the right (exhaust) cam pulley and the idler. Belt tension must be 5.3-5.7 units. If the belt needs adjustment, remove the rubber cap over the tensioner locknut and loosen the locknut.
   a. Insert a prytool between the tensioner wheel and the spring carrier pin to hold the tensioner. If the belt needs to be tightened, move the roller to adjust the tension to 6.0 units. If the belt is too tight, adjust to obtain a reading of 5.0 units on the gauge. Tighten the tensioner locknut and remove the prytool.
   b. Rotate the crankshaft so that the cam pulleys move through one full revolution and recheck the tension on the camshaft belt. It should now be 5.3-5.7 units. Install the plastic plug over the tensioner bolt.
44. Install the remaining belt covers.
45. Start the engine and final check performance.

Intermediate Shaft

REMOVAL & INSTALLATION

B21, B23 and B230 Engines

1. Remove the timing belt cover and the timing belt as explained previously.
2. Remove the hub on the crankshaft, the crankshaft sprocket and the belt guide.
3. Using Volvo tool No. 5034 to hold the intermediate shaft sprocket, remove the center bolt and pull the sprocket off by hand.
4. Remove the two clamps holding the wiring harness on the bottom of the front cover.
5. Remove the six front bolts on the oil pan.
6. Remove the timing belt guard plate and the front cover.
7. Remove the oil pump drive gear cover and lift out the oil pump drive gear.
8. Pull out the intermediate shaft, being careful not to damage the bearings within the block.

To install:

➡When reinstalling, extreme care must be taken to install the shaft without damage to the internal bearing surfaces.

9. Install the oil pump drive gear and its cover.
10. Replace the timing belt guard plate and its cover
11. Install the six front bolts on the oil pan and secure the wiring harness to the bottom of the front cover.
12. Attach the intermediate shaft gear using tool No. 5034. Install and tighten the center bolt.
13. Install the belt guide, the crank gear and the hub on the crankshaft.
14. Install the timing belt and cover as explained in previous sections.

Balance Shafts

REMOVAL & INSTALLATION

B234 Engine

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure.

LEFT SHAFT AND HOUSING

1. Remove the timing and balance shaft belts as described under Timing Belt Removal and Installation.
2. Use a counterhold such as Volvo tool No. 5362 and remove the left side balance shaft pulley.
3. Remove the air mass meter and inlet hose.
4. Unfasten the bracket under the intake manifold and remove the bracket holding the alternator and power steering pump. These may be swung out of the way and tied with wire to the left shock tower.
5. Remove the bolts securing the balance shaft housing to the block. Using an extractor such as Volvo tool No. 5376 or similar, carefully separate the housing from the block. The housing must be removed evenly from both its front and rear mounts.

To install:

6. Clean the joint faces on the cylinder block. Place new O-rings in the grooves around the oil passages on the housing. The rings can be held in place with a light coating of grease.
7. Install the balance shaft housing. Make absolutely sure the housing is evenly mounted on the front and rear mountings. Tighten the bolts alternately in a diagonal pattern. Tighten each bolt ½ turn at a time; tighten them to 15 ft. lbs. (20 Nm). When all the bolts are at 15 ft. lbs. (20 Nm), loosen them individually and tighten each one to 7.5 ft. lbs. (10 Nm) PLUS 90° of rotation.

✱✱WARNING

Make certain that the shaft does not seize within the housing during installation.

8. If the halves of the housing were split apart during the repair, tighten the joint bolts to 6 ft. lbs. (8 Nm).
9. Install the drive pulley. Use a counterholding tool. Note that the pulley has a slot which will align with the guide on the shaft. The shallow side of the pulley faces inward (toward the engine). Tighten the center bolt for the pulley to 37 ft. lbs. (50 Nm).
10. Install the bracket for the alternator and power steering pump. Double check their connections and hoses. Attach the

support under the intake manifold and don't forget the wire clamp on the bottom bolt.

11. Install the air mass meter and its intake hose.
12. Install the balance shaft belt and camshaft belt following the procedures outlined under Timing Belt Removal and Installation.

RIGHT SHAFT AND HOUSING

1. Remove the timing and balance shaft belts as described under Timing Belt Removal and Installation.
2. Use a counterhold such as Volvo tool No. 5362 and remove the left side balance shaft pulley.
3. Remove the balance shaft belt tensioner and remove the bolt running through the backing plate to the balance shaft housing.
4. Remove the air mass meter and its air inlet hose.
5. Remove the air preheat hose from the bottom heat shield at the exhaust manifold. Remove the nuts holding the right engine mount to the crossmember.
6. Connect a hoist or engine lift apparatus to the top of the engine. Lift the engine at the right side, being careful to maintain clearance between the brake master cylinder and the intake manifold.
7. Remove the complete motor mount from the block, including the pad and lower mounting plate.
8. Remove the bolts securing the balance shaft housing to the block. Using an extractor such as Volvo tool No. 5376 or similar, carefully separate the housing from the block. The housing must be removed evenly from both its front and rear mounts.

To install:

9. Clean the joint faces on the cylinder block. Place new O-rings in the grooves around the oil passages on the housing. The rings can be held in place with a light coating of grease.
10. Install the balance shaft housing. Make absolutely sure the housing is evenly mounted on the front and rear mountings. Tighten the bolts alternately in a diagonal pattern. Tighten each bolt ½ turn at a time; tighten them to 15 ft. lbs. (20 Nm). When all the bolts are at 15 ft. lbs. (20 Nm), loosen them individually and tighten each one to 7.5 ft. lbs. (10 Nm) PLUS 90° of rotation.

****WARNING**

Make certain that the shaft does not seize within the housing during installation.

11. If the halves of the housing were split apart during the repair, tighten the joint bolts to 6 ft. lbs. (8 Nm).
12. Install the drive pulley. Use a counterholding tool. Note that the pulley has a slot which will align with the guide on the shaft. The shallow side of the pulley faces inward (toward the engine). Tighten the center bolt for the pulley to 37 ft. lbs. (50 Nm).
13. Install the engine mount onto the block.
14. Using the studs on the crossmember as a guide, lower the engine into place on the front crossmember. When the engine is correctly seated, the lifting apparatus may be removed.
15. Install the air mass meter and its air intake hose.
16. Install the motor mount bolts and the air preheat tube at the lower part of the exhaust manifold.
17. Install the bolt through the backing plate and into the balance shaft housing. Install the belt tensioner, tightening the bolt so that the pulley is movable when the belt is in position.
18. Install the balance shaft and camshaft belts as described in Timing Belt Removal and Installation.

Pistons and Connecting Rods

REMOVAL

B20, B21, B23, B30, B230 and B234 Engines

➧ See Figures 178 and 179

This procedure is more easily accomplished with the engine removed from the vehicle and placed on an engine stand.

1. Remove the cylinder head. Remove any ridge and/or carbon deposits from the upper end of the cylinder bores with a ridge reamer.
2. Remove the oil pan. Check connecting rods and pistons for identification numbers and, if necessary, number them.
3. Remove the connecting rod nuts and caps from the crankshaft. Push the rods away from the crankshaft and install the bearing shells, caps, and nuts on the rods to avoid possible interchange of parts.
4. Push the piston and rod assemblies up and out of the cylinders. Remove the rings. Use care not to let the ends of the rods bang against the cylinder walls.

B27F and B28F Engines

➧ See Figure 180

➡Pistons and cylinder liners are sold as a unit.

1. Remove the engine from the vehicle and remove the cylinder heads. Be sure to hold the liners in place with retainer straps.
2. Remove the 23 bolts holding the front oil pan and remove the oil pan and gasket.
3. Remove the three bolts holding the oil strainer. Remove the rubber ring from the suction pipe.
4. Remove the front baffle plate.
5. Remove the eight main bearing nuts and all of the lower crankcase bolts and remove the lower crankcase. Remove the rubber ring for the oil channel.
6. Install spacers on the main bearing studs and install the main bearing nuts to hold the main bearing caps in position.
7. Check the markings on the connecting rods and caps; make sure they agree with the markings in the illustration. If not, mark each rod and cap yourself.
8. Remove the nuts and bearing caps and press the connecting rods and pistons out of the cylinders.

D24 and D24T Diesel Engines

The best method for engine rebuilding is with the engine removed from the vehicle.

1. Remove the cylinder head and the oil pan.
2. Number the pistons for identification. Number the connecting rods and their caps for identification.

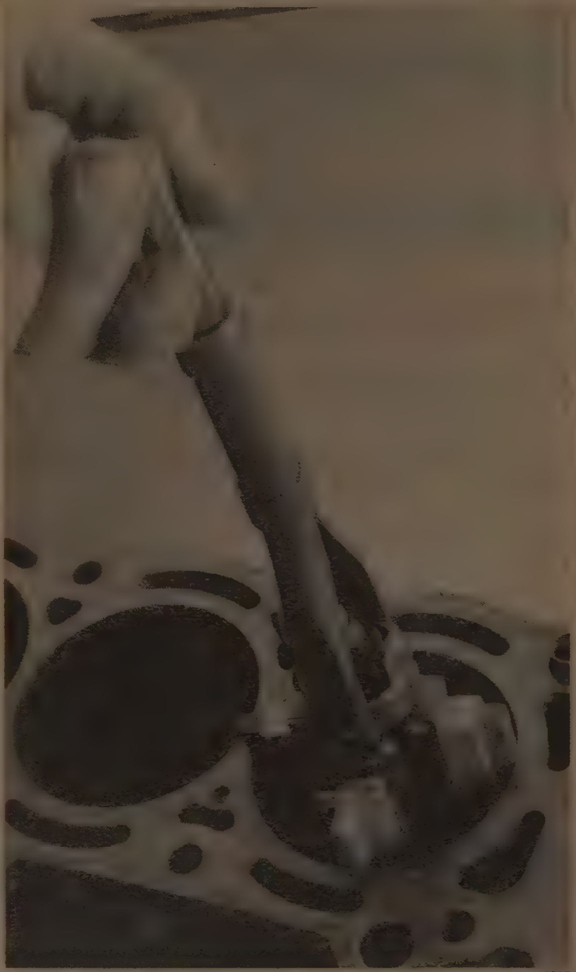


Fig. 178 Remove the ridge from the cylinder bore using a ridge cutter

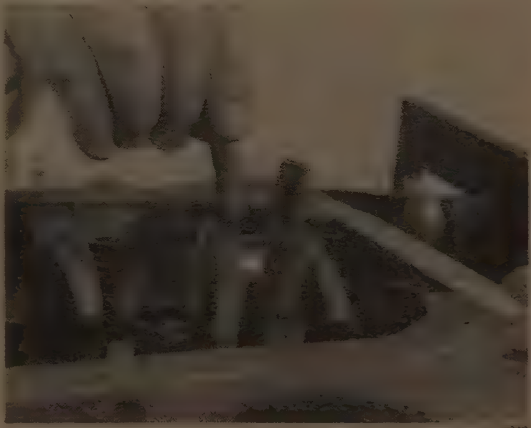
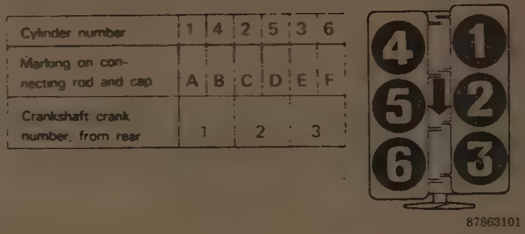


Fig. 179 Protect the crankshaft and cylinders from damage with lengths of hose over the rod studs



Cylinder number	1	4	2	5	3	6
Marking on connecting rod and cap	A	B	C	D	E	F
Crankshaft crank number, from rear	1		2		3	

Fig. 180 Connecting rod marking identification chart — B27F and B28F engines

3. Remove the connecting rod nuts, remove the caps, and push the pistons with connecting rods out of the top of the block.

INSPECTION

➧ See Figures 181, 182, 183, 184 and 185

1. Inspect the cylinder walls for scoring, roughness, or ridges formed by excessive wear. With an accurate cylinder gauge or inside micrometer, check for cylinder taper and out-of-round at the top, middle, and bottom of the bore.
2. Check in directions parallel and at right angles to the center line of the engine. Wear is indicated by the difference between the highest and lowest readings. The cylinder is in need of reboring when wear reaches 0.010 in. (0.25mm), or if scoring is evident.
3. Use a hone or rebore the cylinder for fitting of smallest possible oversized piston and rings. Clearance between the piston and cylinder wall, with the rings removed, should be 0.0008-0.0016 in. (0.02-0.04mm) for the B20 and B30 engines

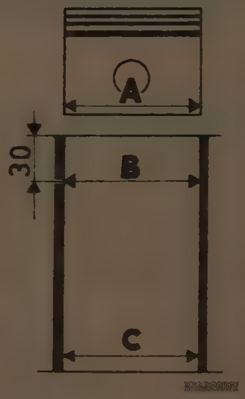


Fig. 181 Measure across the dimensions shown to determine taper and wear. Measurement "B" is made 1.20 in. (30mm) from the block face

and 0.0004-0.0012 in. (0.01-0.03mm) for the B21/B23/B230/B234 engines. For the B27 engine equipped with Demolin pistons, clearance should be 0.00315-0.00394 in. (0.08-0.10mm). On the B27/B28/B280 engine equipped with Mahle pistons, clearance should be 0.0008-0.0016 in. (0.02-0.04mm).

4. Check the piston ring end-gap by pressing each ring into the cylinder bore and squaring it in the bore with the piston. Insert a feeler gauge into the gap. Check the gap against the specifications given earlier in this section. The gap may be widened by filing the ring ends with a thin flat file.

5. Clean the ring grooves on the sides of the pistons. With the rings installed in their respective grooves, measure the side clearance at several points around the piston, and check the reading against the specifications. Inspect the ring grooves for wear, especially the upper edge of the chromed top compression ring.

6. The wrist pins on the B20, B30, and B21/B23/B230/B234 engines are removed after the circlips are taken out of the wrist pin bores. The wrist pins should slide out.

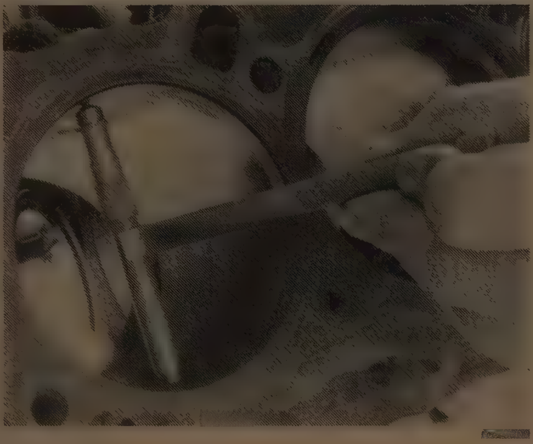


Fig. 182 A telescoping gauge may be used to measure the cylinder bore diameter

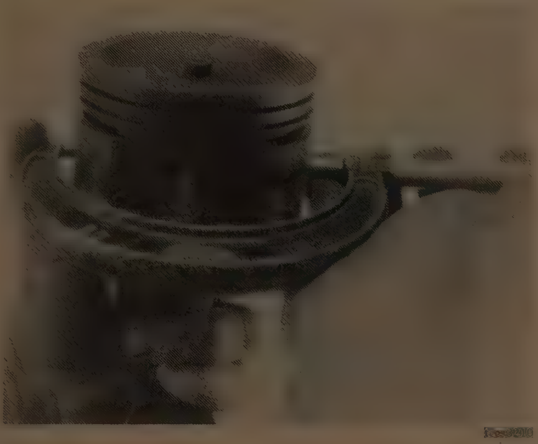
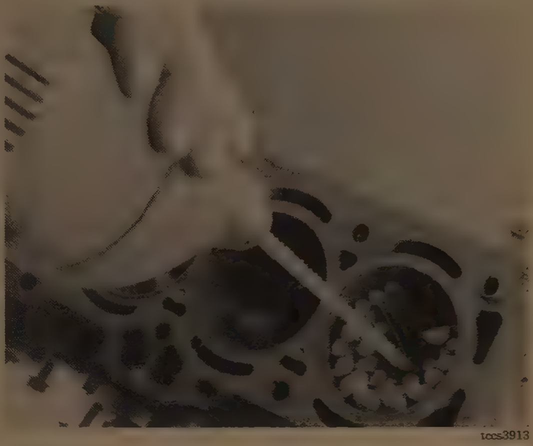
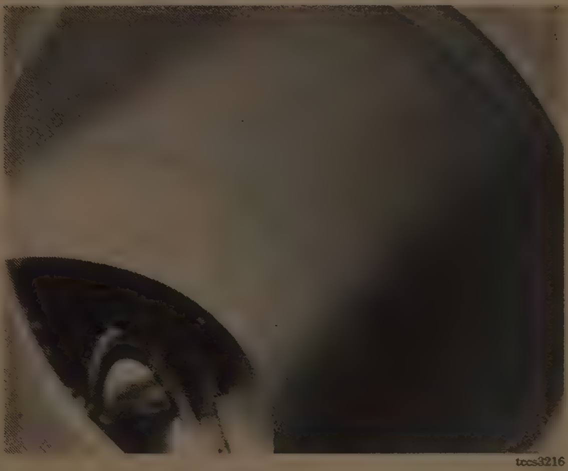


Fig. 183 Measure the piston's outer diameter using a micrometer



tccs3913

Fig. 184 Using a ball type cylinder hone is an easy way to hone the cylinder bore



tccs3216

Fig. 185 A properly cross-hatched cylinder bore

7. The wrist pins on the B27/B28/B280 engine and the diesel must be pressed out using a hydraulic press. On the B27/B28/B280 engine, press the wrist pin in and out in the direction opposite to the arrow on the piston. (When installing, heat the connecting rod to 480°F (249°C).

8. On the B27/B28/B280, once the wrist pin is removed the piston cannot be reused because of deformation. On the diesel engine, remove the circlips, then press out the pin. If the pin is tight, heat the piston to 140°F (60°C).

9. Check the connecting rods for straightness, and check the bushings for excessive wear. The wrist pin should slide through the bushing with light thumb pressure, but without noticeable looseness.

INSTALLATION

➧ See Figures 186, 187, 188, 189, 190 and 191

On all engines, the notch or arrow stamped on top of the piston must face the front of the engine. On B20 and B30 engines, the connecting rod crank end marking must face away from the camshaft side. On the B21/B23/B230/B234, the connecting rod marking must face the front of the engine.

On the B27/B28/B280, the shoulder on the crankshaft end of the connecting rod must point toward the front of the engine for connecting rods marked B, D, or F (for cylinders 4, 5 and 6). The shoulder on the crankshaft end of the connecting rod must face toward the rear end of the engine for connecting rods marked A, C, or E (for cylinder 1, 2 and 3).

For diesel engines, the cast marks on the connecting rod and cap must face toward the oil filter side of the engine.

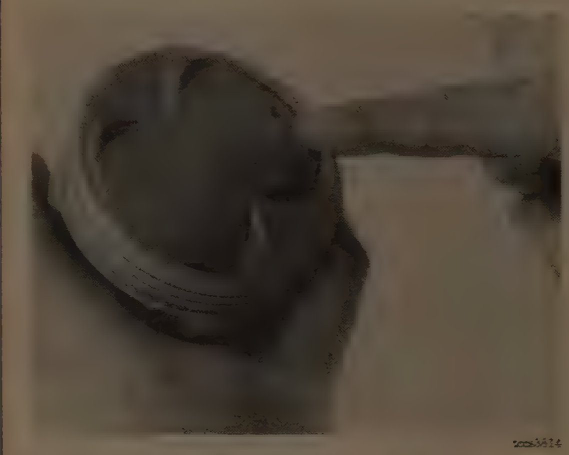

tccs3614

Fig. 186 Most pistons are marked to indicate positioning (usually a mark means the side facing front)

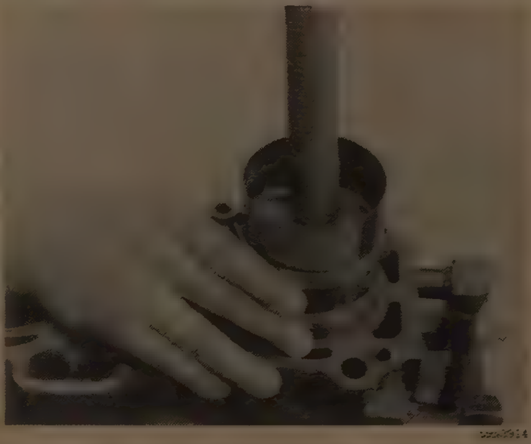
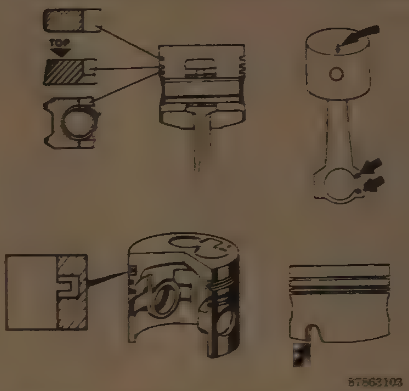

tccs3914

Fig. 187 Installing the piston into the block using a ring compressor and the handle of a hammer



87563103

Fig. 188 Install the diesel engine pistons and connecting rods with the marks facing the front of the engine. The upward-facing portion of the lower compression ring is marked "TOP"

tccs2211

Fig. 189 Use a ring expander to remove the piston rings

tccs2208

Fig. 190 Clean the piston grooves using a ring groove cleaner

Fig. 191 You can use a piece from an old ring to clean the ring grooves, but BE CAREFUL, the ring is sharp

Cylinder Liners and Seals

REMOVAL & INSTALLATION

B27, B28 and B280 Engines

➧ See Figures 192 and 193

These models are equipped with wet cylinder liners which are inserted into the block and are sealed off from the coolant jacket by the head gasket and a bottom shim. The tightness of the heads on the block seals the liners.After the pistons have been removed, the liners may be removed from the block. Check the mating surfaces and make sure they are clean and free of defects.

When installing liners, it is very important to obtain the correct liner height above the block. The correct height is 0.0063-0.0091 in. (0.16-0.23mm) with 0.0091 in. (0.23mm) preferred. This height is adjustable by using shims at the bottom of the liner.

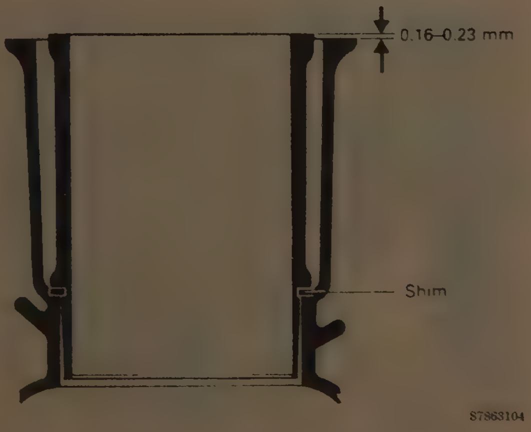


Fig. 192 Relationship of the cylinder liner, shim and block

Install the new liner in cylinder No. 1 and use the retainer bar finger-tight to hold it in place. Measure the liner height at three different locations. Use the highest reading as a basis for calculating the proper shim height. Select a shim which is at or just under the calculated necessary thickness.

Install the same size shim on all liners and install the liners in the motor. The color marking should face upward and be visible when the liner is installed. The tongues on the inside of the shim should fit into the groove in the liner. (In the diagram A is the color marking, B shows the tongues and C indicates the liner groove). Again measure the liner projection above the deck for EACH liner and exchange shims as necessary.

LOWER CRANKCASE INSTALLATION

B27, B28 and B280 Engines

➧ See Figure 194

After the pistons and connecting rods have been installed, install the rubber ring for the oil channel and apply sealing compound to the block surfaces. Remove the main bearing nuts and the spacers and make certain that none of the studs have come loose.

Position the lower crankcase in place and install all nuts and bolts but do not tighten. Make sure that lower crankcase and the block are flush at the rear of the block to prevent warpage of the flywheel casing. Tighten the eight main bearing nuts to 22 ft. lbs. (30 Nm) in the sequence shown in the illustration. Loosen nut no. 1 in the illustration then tighten it to 22-25 ft. lbs. (30-34 Nm).

Install a protractor attachment to the torque wrench socket and set up a stationary pointer for reference. Tighten nut No.1 to 73-77° according to the protractor on the socket. Repeat this procedure with nuts 2, 3, 4, 5, 6, 7 and 8 in the illustration in that order. Tighten all of the attaching bolts in lower crankcase except the rear seal retainer bolts to 11-15 ft. lbs. (15-20 Nm). Tighten the rear seal retainer bolts to 7-11 ft. lbs. (9-15 Nm).

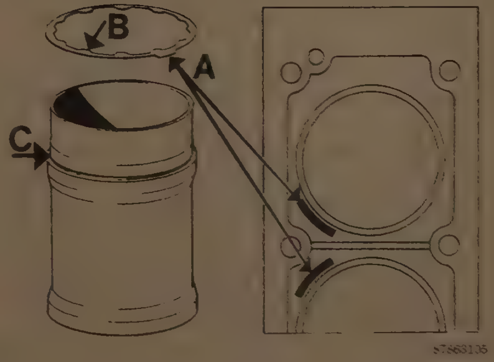


Fig. 193 Place the cylinder liner shim as shown

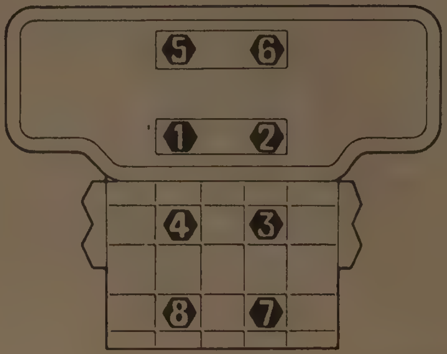


Fig. 194 Lower crankcase tightening sequence — B27F, B28F and B280F engines

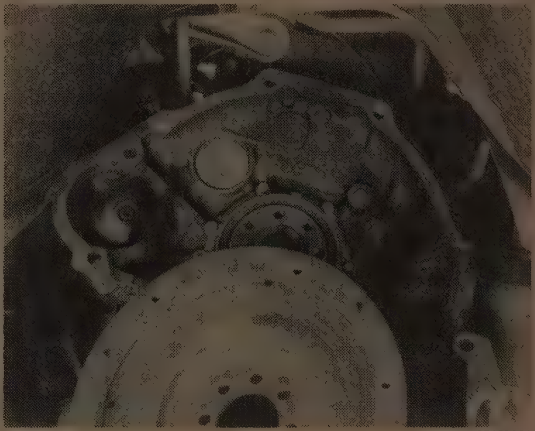


Fig. 195 Remove the transmission, clutch and flywheel (shown) to access the rear main oil seal

Rear Main Oil Seal

REMOVAL & INSTALLATION

All Models

See Figures 195, 196, 197, 198, 199, 200, 201 and 202

1. Remove the transmission, clutch (if so equipped), and flywheel (match mark with crankshaft) from the engine. Remove the two pan bolts from the bottom of the sealing flange on all models except the diesel, and loosen two more on each side so that the pressure on the sealing flange is reduced.
2. On B20, B30, and B21 engines, remove the sealing flange retaining bolts and pull off the sealing flange and old gasket. Press out the sealing ring in the flange with a drift. On the B20 with felt ring type seal, remove the circlip and washer first.
3. For all other models, including the diesel, use a prytool to pry the rear seal out of the flange. Do not remove the flange from the engine and use caution not to damage surfaces on flange (holder) or crankshaft. For the B23/B230/B234 family, note the position of the seal in relation to the flange; the new seal must be reinstalled in the same position.

To install:

4. Make sure the sealing surfaces of the flange are clean. Also, make sure that the oil drain hole is not blocked by the oil pan gasket.
5. On the B20 with rubber seal, and all other engines, oil and install the oil seal in the flange. This job is correctly done with a seal driver of the proper diameter. Volvo has several special tools available for this purpose (tool numbers vary by engine application); similar tools are available from reliable retail suppliers. If buying tools, make sure the set includes the diameter you need for the particular job at hand.

➡When installing the oil seal in the flange on the B30 engine, if you have access to Volvo tool No. 2817, the oil seal can be installed in three different positions according to crankshaft wear. On a new or unworn crankshaft, fit the seal in its outer position (the center bolt in the tool fully

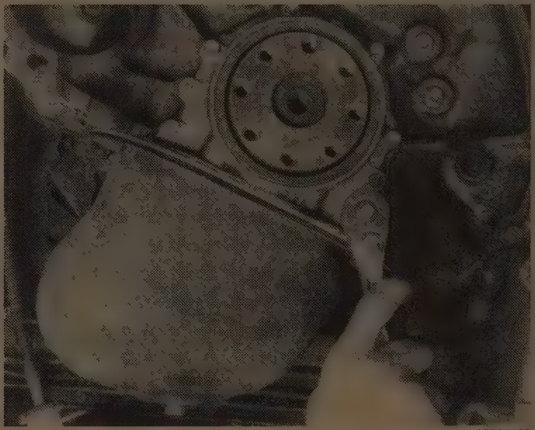


Fig. 196 This seal flange (retained with six screws) must be removed to access the seal

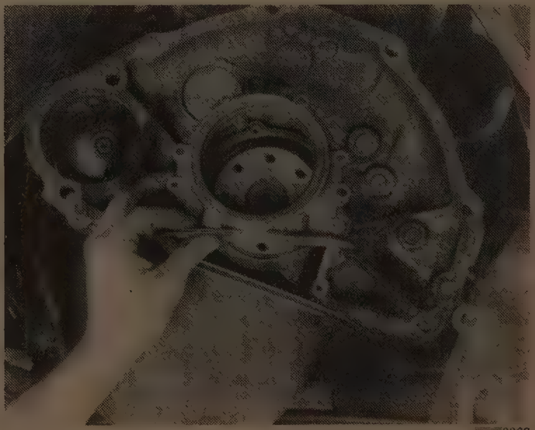


Fig. 197 Remove the seal flange, then take it to a clean work bench

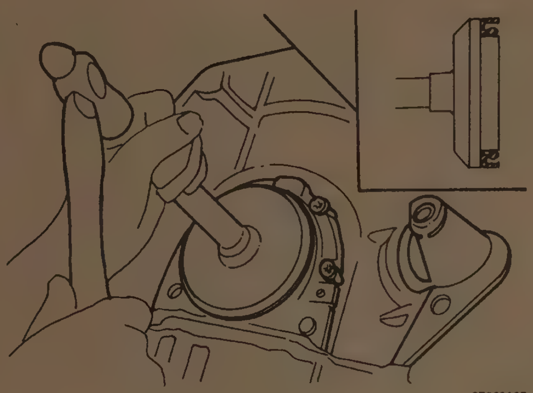


Fig. 198 Use a suitable seal driver to install the rear crankshaft oil seal — Volvo special tool shown

screwed in). On a worn crankshaft, fit the seal with the center bolt in the tool screwed out a couple of turns or completely. The seals for the B23/B230/B234 can also be sized by removing the appropriate spacer rings before installation; to do this, the use of Volvo tool No. 5276 is required. On the B20 engine with felt seal, install and center the flange on the engine (tool No. 2439) then check that the flange is flush against the under side of the block and fit a new felt ring, washer and circlip. Make sure the circlip is engaged in its groove. On the diesel engine, oil and install the rear seal in the flange, being careful not to damage the seal lip.

6. Using gentle force, tap the seal in until the installing tool abuts the crankshaft.
7. Install and tighten such oil pan bolts as were loosened for access.
8. Install flywheel (or flexplate for automatic trans), observing proper placement onto crankshaft. Carefully observe placement of any shims, washers or locking hardware involved. Tighten the bolts in a diagonal pattern as follows:
    - B21/B23/B230/B234 engines: 50 ft. lbs. (68 Nm)
    - B27/B28/B280 engines: 35 ft. lbs. (47 Nm)
    - D24/D24T engines: 55 ft. lbs. (75 Nm)
9. Install clutch assembly if so equipped.
10. Install the transmission.

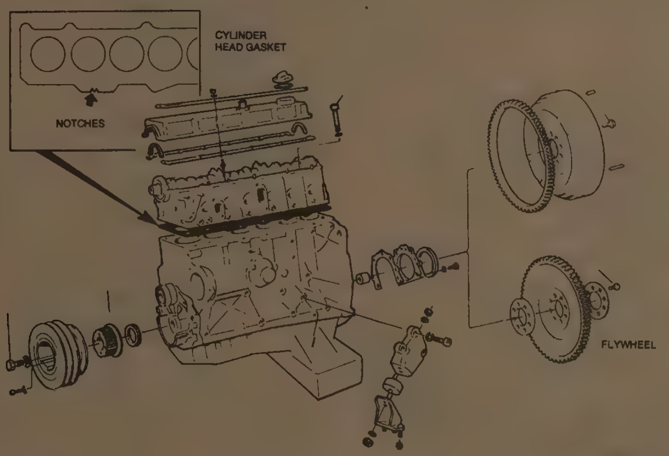


Fig. 199 Exploded view of the diesel engine

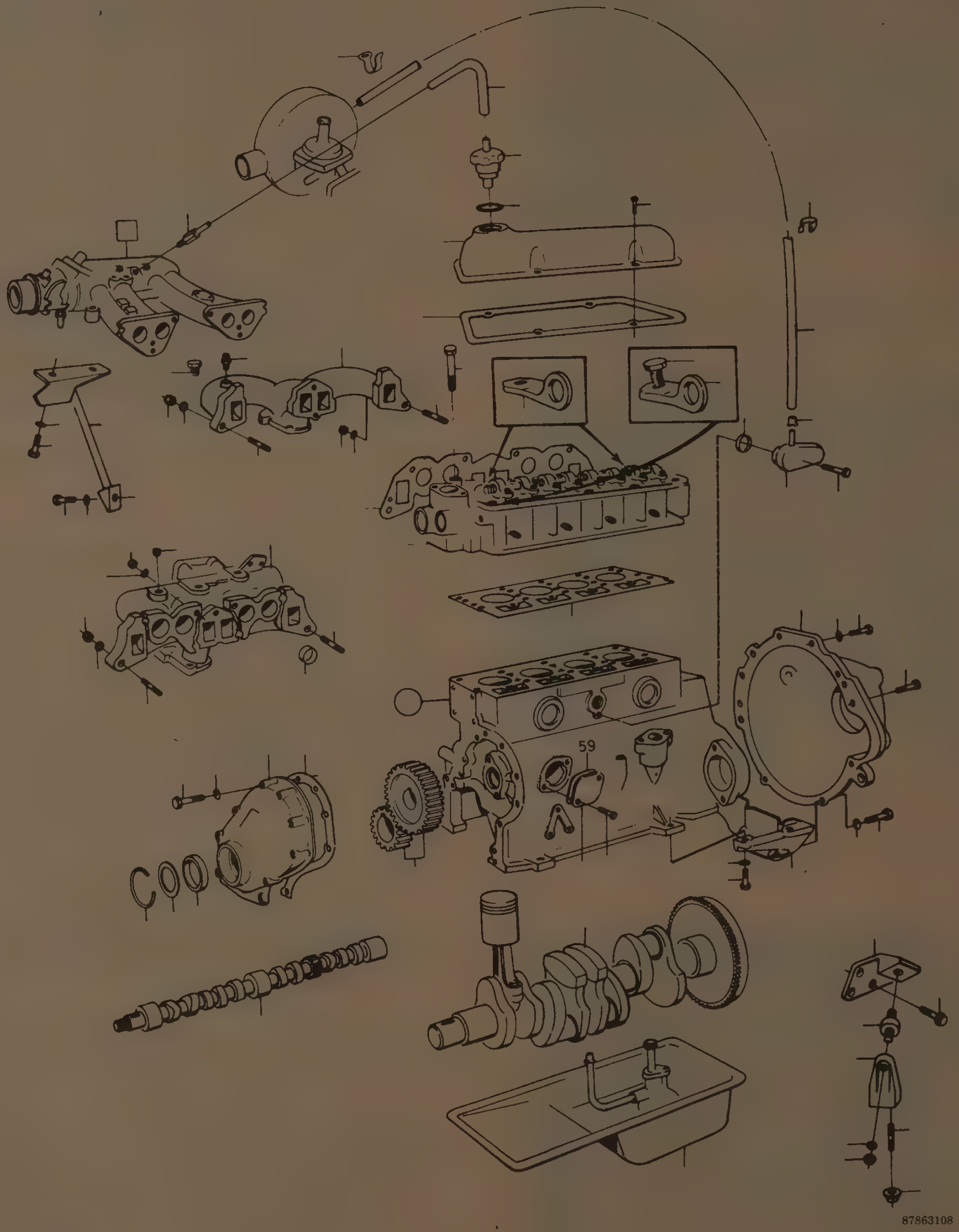

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Fig. 200 Exploded view of the B20 engine — the B30 engine is similar

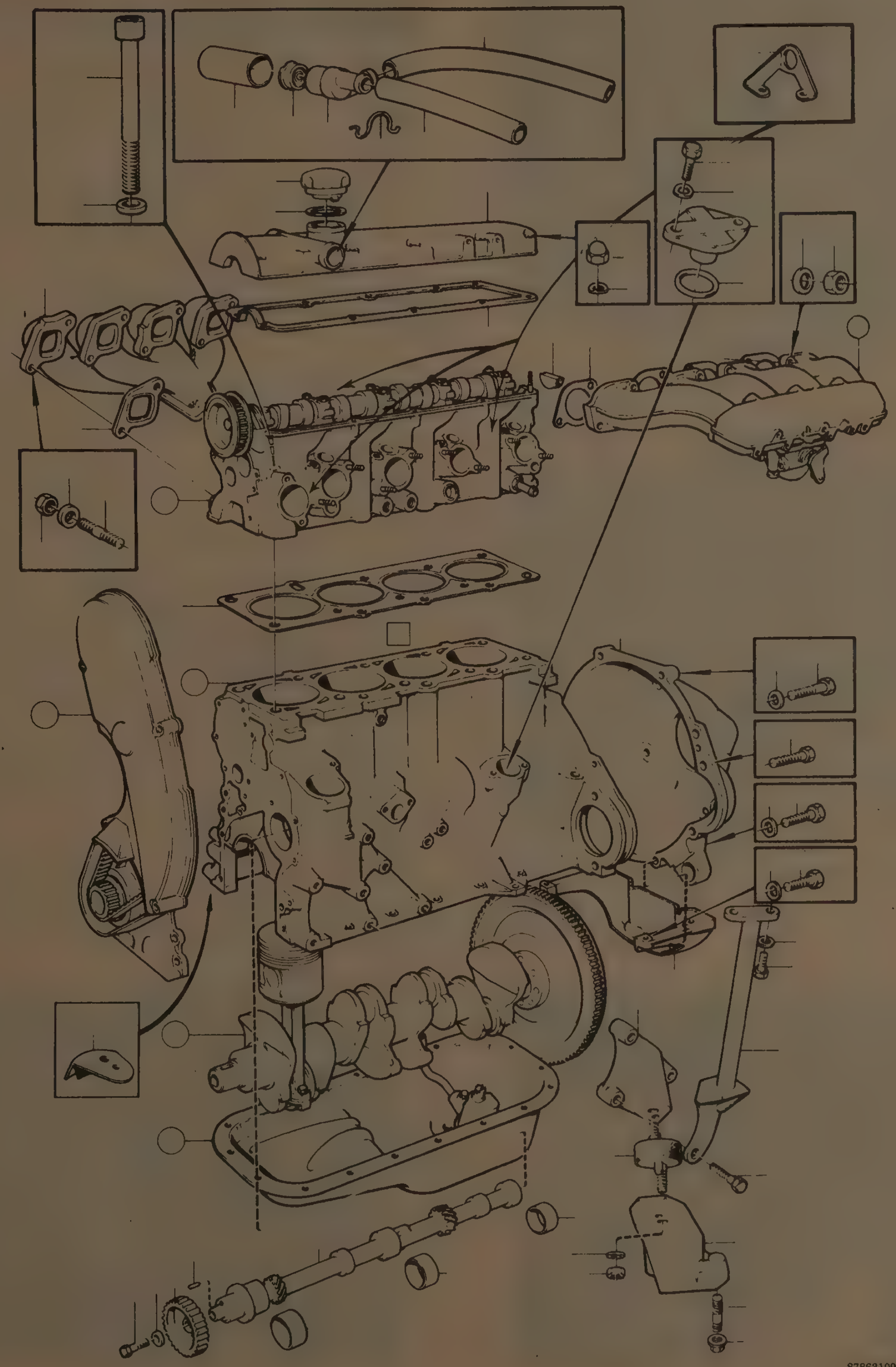

Fig. 201 Exploded view of the B21 engine — the B23 engine is similar

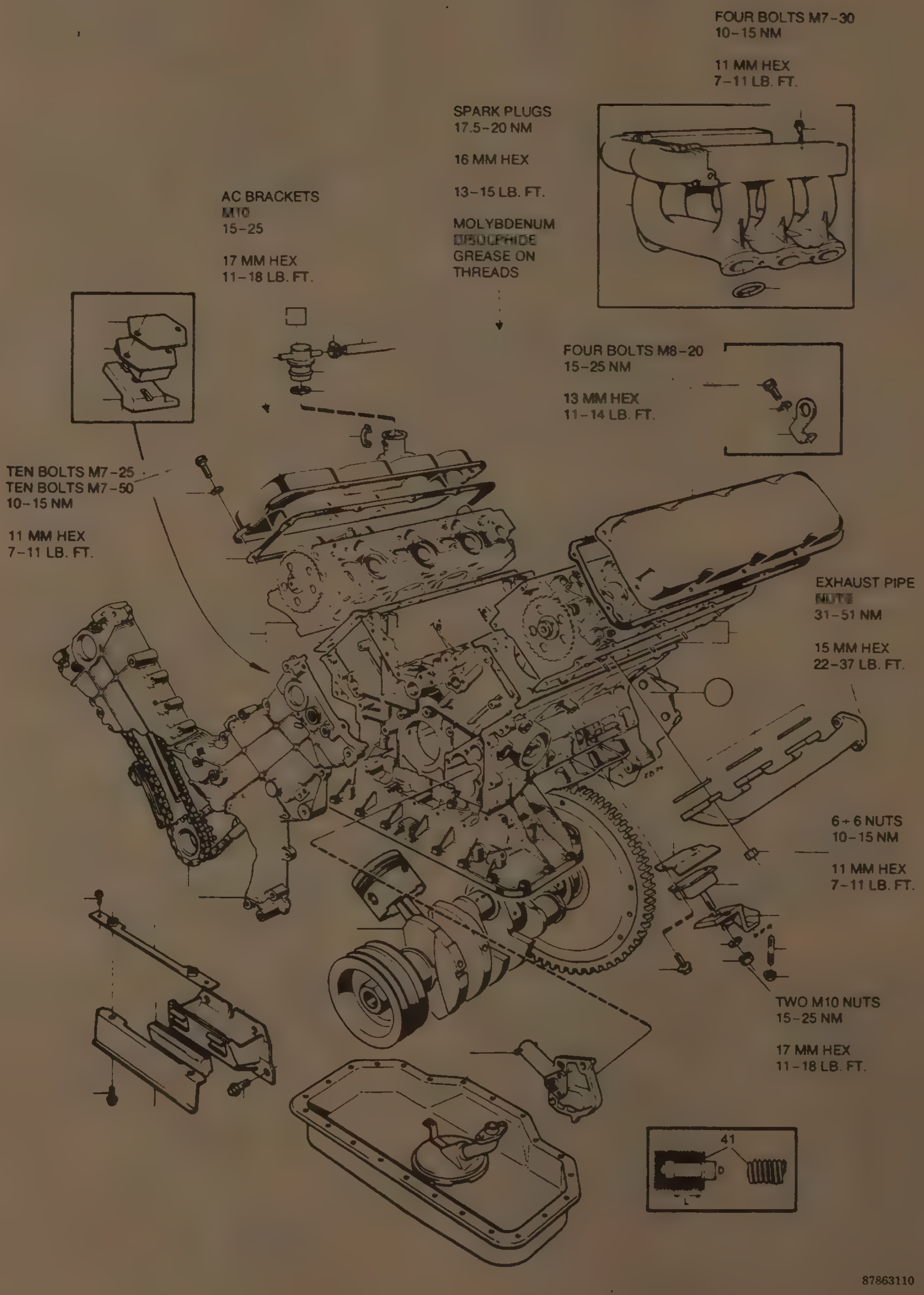
FOUR BOLTS M7-30
10-15 NM
11 MM HEX
7-11 LB. FT.
SPARK PLUGS
17.5-20 NM
16 MM HEX
13-15 LB. FT.
MOLYBDENUM
DISULPHIDE
GREASE ON
THREADS
AC BRACKETS
M10
15-25
17 MM HEX
11-18 LB. FT.
FOUR BOLTS M8-20
15-25 NM
13 MM HEX
11-14 LB. FT.
TEN BOLTS M7-25
TEN BOLTS M7-50
10-15 NM
11 MM HEX
7-11 LB. FT.
EXHAUST PIPE
NUTS
31-51 NM
15 MM HEX
22-37 LB. FT.
6+6 NUTS
10-15 NM
11 MM HEX
7-11 LB. FT.
TWO M10 NUTS
15-25 NM
17 MM HEX
11-18 LB. FT.
41
D
L
87863110

Fig. 202 Exploded view of the B27 engine — the B28F engine is similar

Crankshaft and Main Bearings

REMOVAL & INSTALLATION

See Figures 203, 204, 205 and 206

➡This procedure requires the removal of the engine from the vehicle and placement on an engine stand. It cannot be done with the motor in the car.

1. Follow the procedures under piston and connecting rod removal in this section.
2. Remove the pressure plate and clutch disc or, if automatic transmission, the flexplate. Loosen the bolts diagonally, a few turns at a time, to prevent warping. It will be necessary to lock the flywheel (or flexplate) in position while loosening its retaining bolts. Matchmark the flywheel and crankshaft before disassembly so that the parts may be reconnected in the same relationship.
3. Remove the rear sealing flange and the front cover plate from the block.
4. Check the main bearing caps for identification numbers and, if necessary, number them.
5. Unbolt and remove the main bearing caps and lift the crankshaft out of the block. You are reminded that the crankshaft is a heavy component.

➡Do not interchange bearing shells and caps.

6. Remove the bearings from the main caps and the block.

To install:

7. Installation is the reverse of the removal procedures taking note of the following:
   a. Make sure that matched bearing pairs are installed together.
   b. The holes in the bearing shells must coincide with the oilways in the engine block.
   c. Check the bearing clearances with Plastigage.
   d. Lubricate the bearing shells and bearing surfaces on the crankshaft.

87863316

Fig. 203 Use a long handled breaker tool to loosen the bolts

87863317

Fig. 204 Remove and set aside the main bearing bolts

87863318

Fig. 205 Pull away the bearing cap from its mounted position

87863319

Fig. 206 Separate the bearing from the cap and set aside in an organized fashion

e. Tighten the main bearing caps to specification and check the crankshaft end play.

CRANKSHAFT CLEANING AND INSPECTION

See Figures 207, 208 and 209

1. Clean the oilways in the crankshaft with a piece of wire and blow them out with compressed air. Also check and clean the sealing surfaces on the crankshaft.
2. Measure out-of roundness and taper of crank pins (journals). Use a micrometer and take measurements at several different positions. Maximum out-of-round is 0.0003 in. (0.008mm) and the maximum taper is 0.0004 in. (0.01mm). Crank pins can be ground to a smaller size. Regrinding should be perfomed by a competent machine shop.
3. If a warped crankshaft is suspected, it should be checked with a dial indicator. Support the crankshaft by the two outer main bearing journals on V-blocks. Rotate the crankshaft one turn and measure the out-of-true for the two center crankpins. Maximum warpage is 0.02mm (0.0008 in.).

CHECKING BEARING CLEARANCE

See Figures 210 and 211

Invert the engine on its stand and remove the cap from the bearing to be checked. Using a clean dry rag, thoroughly clean all oil from crankshaft journal and bearing insert.

➡Plastigage® is soluble in oil; any oil on the journal or bearing could result in erroneous readings.

Place a piece of Plastigage® along the full length of journal, reinstall cap, and tighten to the specifications given in the chart earlier in this section.

Remove bearing cap, and determine bearing clearance by comparing the width of Plastigage® to the scale on Plastigage® envelope. Journal taper is determined by comparing

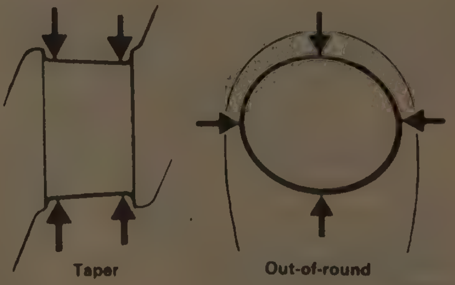

Fig. 207 Use a micrometer to measure out-of-roundness and taper of crank pins (journals)

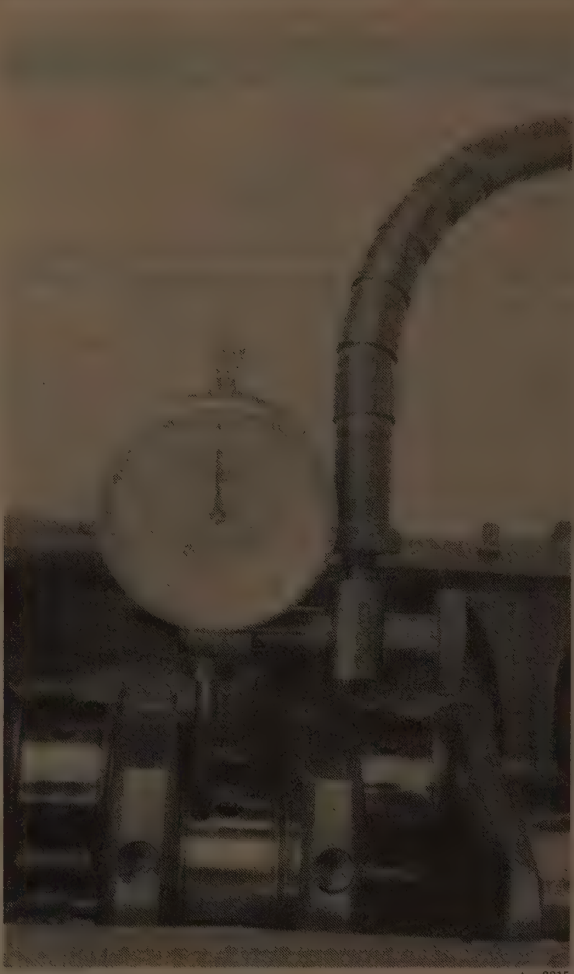
tccs3815

Fig. 208 A mounted a dial gauge to read crankshaft runout

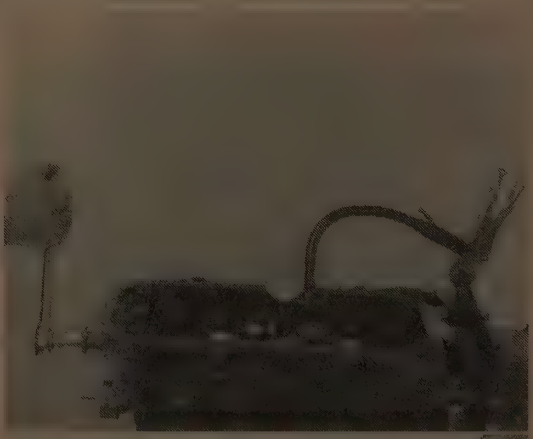

Fig. 209 Turn the crankshaft slowly by hand while checking the gauge

tccs3243

Fig. 210 Apply a strip of gauging material to the bearing journal, then install and tighten the cap

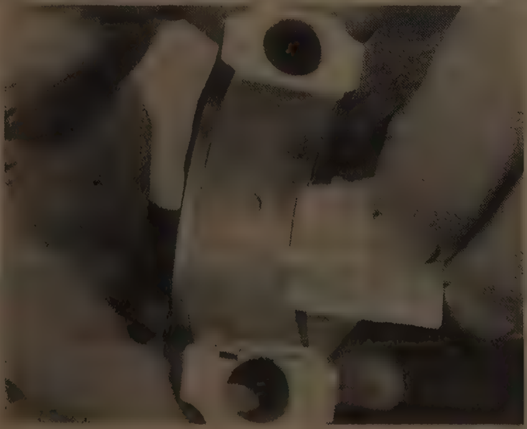
tccs3912

Fig. 211 After the bearing cap is removed, use the supplied gauge to check bearing clearances

width of the Plastigage® strip near its ends. Rotate crankshaft 90° and retest, to determine journal eccentricity.

➡**Do not rotate crankshaft with Plastigage® installed.**

If bearing insert and journal appear intact and are within tolerances, no further main bearing service is required. If bearing or journal appear defective, cause of failure should be determined and repaired before replacement and reassembly.

Flywheel and Ring Gear

REMOVAL & INSTALLATION

The ring gear is contacted by the starter gear during engine start up. If any damage is found on the ring gear (broken or chipped teeth, cracks, etc.) the cause of the failure should be identified and repaired. The starter should be checked as a possible cause.

On vehicles with automatic transmission, the ring gear is an integral part of the flexplate and cannot be replaced. On vehicles with manual gearboxes, the ring gear on the flywheel can be removed and replaced. This replacement involves heating the ring to 450°F, and handling the heated ring. It is usually found to be easier to buy a complete flywheel and ring gear assembly than to attempt the replacement. If you possess the proper equipment for heating and handling the ring gear, the procedure is as follows:

1. Remove the transmission.
2. Remove the clutch plate and disc.
3. Remove the bolts attaching the flywheel to the crankshaft flange. Remove the flywheel.
4. Inspect the flywheel for cracks, and inspect the ring gear for burrs or worn teeth. Replace the flywheel or ring gear if any damage is apparent. Remove burrs with a mill file.

To install:

5. To replace a ring gear use the following steps.
   a. Use a 10mm drill and drill a hole between two cogs (teeth) on the ring gear, being careful not to drill into the flywheel.
   b. Mount the flywheel in a vise protected by soft jaws and split the ring gear at the hole with a chisel.
   c. Heat the new ring gear to approximately 450°F. When handling the heated ring, wear heavy gloves and use tongs.
   d. Position the ring gear with the bevelled side facing the flywheel.
   e. Use a brass drift and tap the ring gear until flush. Allow to air cool before installation; do not attempt to cool the metal with water, oil or other fluids.
6. Install the flywheel. Install the bolts and tighten to specification.

EXHAUST SYSTEM

Components

GENERAL INFORMATION

See Figures 212, 213, 214, 215 and 216

The exhaust system serves to conduct and silence the flow of hot gasses out of the engine. While it appears to be simple plumbing, the science of exhaust flow is quite complex. Pipe diameter, bend radius, manifold design and internal structure of components all play a part in the efficient extraction of exhaust gasses.

When performing repairs on the exhaust system, it is important to use replacement parts which are virtually identical to the originals. Failure to do so may result in impaired or restricted function and/or a host of body rattles caused by improperly mounted pipes hitting the undercarriage.

The exhaust system is generally mounted in such a way as to be insulated from the body of the car. Many rubber hangers, washers and bushings are used to reduce noise and vibration. Their placement should be accurately noted during removal so that they can be properly reinstalled. If any rubber component has lost its flexibility, it should be replaced.

Working on an exhaust system is a project of mixed emotions; being held together simply with nuts and bolts, and generally having easy access, one could lulled into thinking it a simple job. On any car more than a year old, those simple nuts and bolts have rusted solid from both heat and water. Joints have solidified and the entire system has become brittle. Chances are high that if one component has rusted through, its adjoining pieces are suspect.

Arm yourself in advance. Have a healthy supply of rust penetrant and rags on hand. In addition to the proper assortment of wrenches, you'll need good eye protection, gloves, a hammer, probably a cold chisel and possibly a small prybar. On very old systems, it is sometimes easier to simply chisel the end off the bolt and replace it than to attempt to loosen the nut. New hardware and gaskets are always recommended during any exhaust repair.

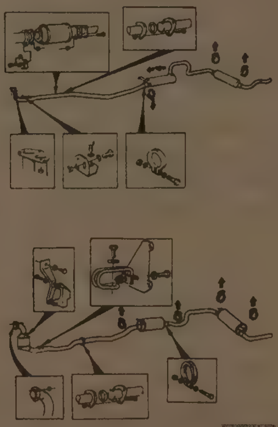

Fig. 212 B21 and B23 exhaust systems. Upper: A, E and F models. Lower: ET and FT (turbo) models

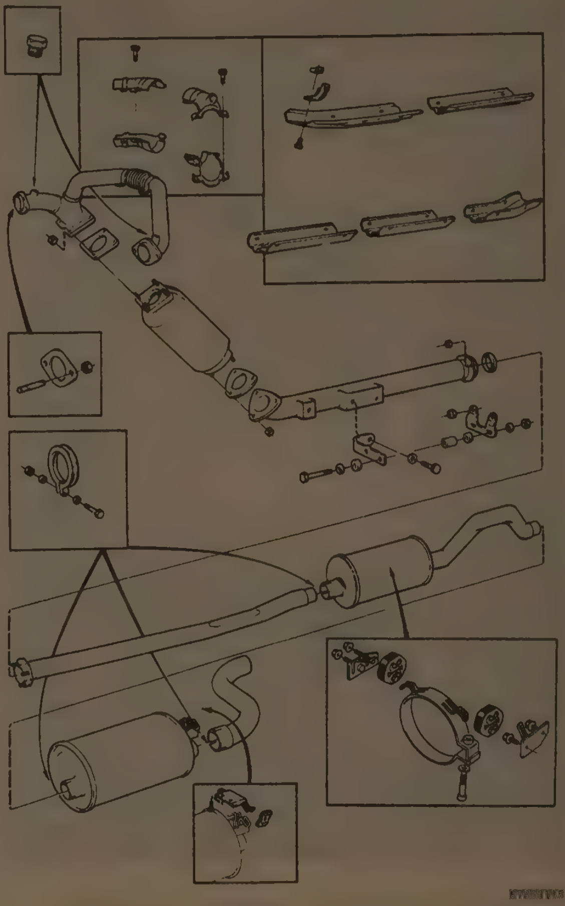

Fig. 213 Common B28F exhaust system — the heat shields shown in the upper right of the illustration are not found on all models

Since exhaust systems vary by engine design, fuel system and country of sale, it would be impossible to describe each component and system. Several representative diagrams have been included, showing component placement and hook up. To remove the complete system, follow the general rules below:

CAUTION

Only work on the exhaust system when ALL components are cool to the touch. Catalytic converters can develop surface temperatures of 300°. Always wear eye protection and gloves. Make sure the car is properly supported on jackstands.

1. Work from the front joint to the rear. If the system hangs at the rear, it can create enough force to crack or damage the exhaust manifold. In general the manifold pipe connects to the

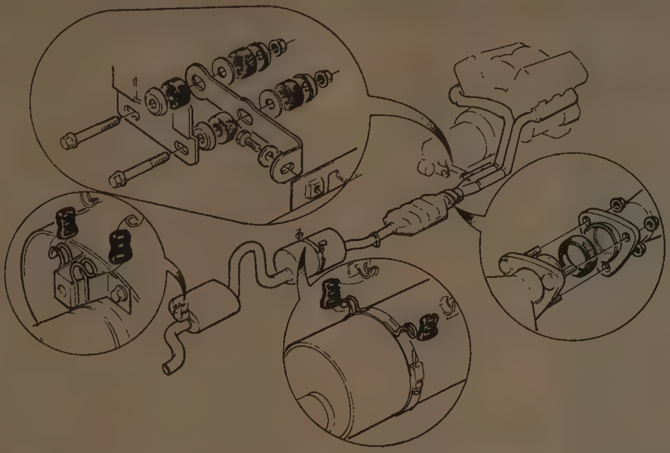

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Fig. 214 Common B28F exhaust system — note the extensive use of rubber hangers and insulators

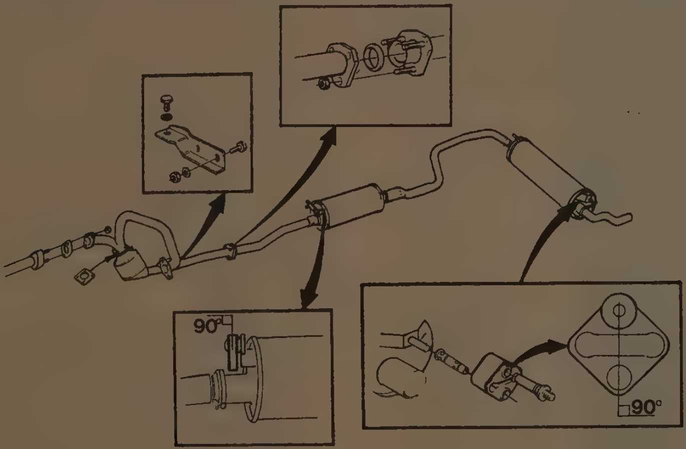

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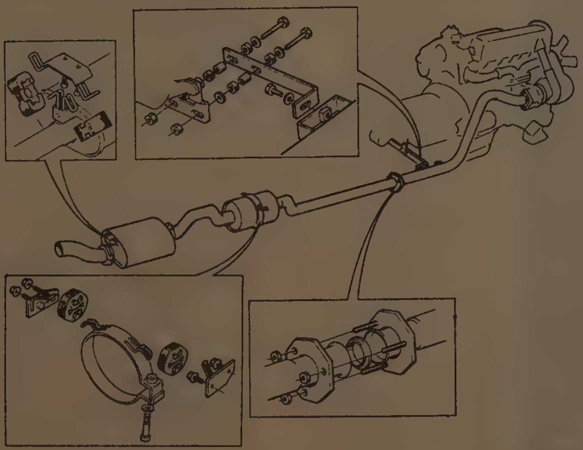
Fig. 215 B27 and B28 exhaust system as equipped through to the 1983 model year



87863118

Fig. 216 Common diesel engine exhaust system

exhaust pipe near the transmission case. Loosen and disconnect the bracket holding the exhaust to the transmission case, then disconnect the joint at the manifold pipe.

2. Working towards the rear of the car, disconnect the various hangers and mounts until the complete system is free of the car. Remove the system from under the car; it is easier to work on specific pipe joints with the system removed.

3. Perform necessary replacements or repairs. Carefully observe the placement of all seal and gaskets when disassembling. Safe and quiet operation depends on these seals being properly installed.

To install:

4. When reassembling any joint, the use of new gaskets, seals and hardware is highly recommended. Reassemble the entire system and place it under the car.

5. Lift the system to the underside of the car and connect one or two of the hangers, allowing the system to swing as necessary.

6. Again working from front to rear, secure the joint at the exhaust manifold and progress towards the rear of the car, installing the hangers and clamps.

7. Constantly check for pipe to body interference; remember that the system is not rigidly mounted and must be free to move under the car. Minimum clearance to any body part should be ³⁄₈ inch (10mm), with ¹⁄₂-³⁄₄ inch (13-19mm) preferred where possible.

8. It may be necessary to adjust the length of the system for proper fit. Do this by loosening the clamp at one of the pipe joints at the muffler or resonator (pre-muffler) and telescoping the pipe in or out as needed. Don't forget to retighten the clamp when the proper length is achieved.

9. After the system is installed, lower the car from its elevated position. Start the engine and check for rattles and exhaust leaks. A quick check for system leaks is to protect your palm with a folded rag and place it over the end of the exhaust pipe, blocking the flow. An air tight system will develop enough pressure to push your hand away very quickly. If there's a leak, you'll be able to hear a hissing under the car.

COMPONENT REPLACEMENT

As a rule, if any component is attached at both ends, it's easier to remove the entire system from the car and do the repair where you can see it. The rear muffler can be removed by disconnecting it at the pipe joint and then removing the hanger(s). Remember to use new gaskets and hardware when reassembling. Double check the muffler and eliminate any possible contact with the undercarriage.

Catalytic Converter System

There are two different types of catalytic converters used on Volvos: the oxidation type converter and the three-way converter.

All 1975-76 Volvos manufactured for California, 1975 164 models with manual transmission and overdrive for the 49 states, 1977 49 states 240 series and all 1977 260 series, all 1978 49 states models except some 242 DL, 242 GT and 262 C models, and all 1979 49 states 240 models except the 242 GT are equipped with the oxidation type converter.

The converters are installed in these vehicles to further control emissions of carbon monoxide and hydrocarbons which have resisted the treatment of the air injection system. The converter is installed in the exhaust system ahead of the muffler. The converter uses platinum and palladium metals in a substrate or beaded form as the catalyst.

The catalyst and the oxygen supplied by the air pump then react with the exhaust gases producing harmless carbon dioxide and water vapor, as well as a minute amount of sulphur dioxide or sulfuric acid. The converter is designed to last 50,000 miles (80,515 km) as long as leaded gasoline is not used. The lead in gasoline will coat the catalytic substrate or beads, preventing the reaction process and rendering the converter ineffective.

At 15,000 mile (24,155 km) intervals, the retaining bolts for the converter must be checked for tightness. A service reminder light on the dashboard lights at 15,000 mile (24,155 km) intervals.

The 1977 California 240 series, all 1978-80 260 California series, all 1979 49 states 260 series, all 1980 and later (except diesel) models and the 1979 49 states 242 GT are equipped with three way catalytic converters.

The purpose of the three way catalytic converter is to neutralize carbon monoxide, hydrocarbons and oxides of nitrogen in the exhaust gases. The main difference between this catalytic converter and the oxidation converter is that the three way converter is able to process large amounts of oxides of nitrogen (NOx), while the oxidation catalyst cannot.

As with the oxidation catalytic converter, the use of leaded fuel or fuel additives in the engine will render the three way catalyst ineffective.

4

EMISSION CONTROLS

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AUTOMOTIVE EMISSIONS 4-3
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VACUUM DIAGRAMS 4-20

AIR POLLUTION

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- INDUSTRIAL POLLUTANTS 4-2
- NATURAL POLLUTANTS 4-2

AUTOMOTIVE EMISSIONS

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AIR POLLUTION

The earth's atmosphere, at or near sea level, consists approximately of 78 percent nitrogen, 21 percent oxygen and 1 percent other gases. If it were possible to remain in this state, 100 percent clean air would result. However, many varied sources allow other gases and particulates to mix with the clean air, causing our atmosphere to become unclean or polluted.

Certain of these pollutants are visible while others are invisible, with each having the capability of causing distress to the eyes, ears, throat, skin and respiratory system. Should these pollutants become concentrated in a specific area and under certain conditions, death could result due to the displacement or chemical change of the oxygen content in the air. These pollutants can also cause great damage to the environment and to the many man made objects that are exposed to the elements.

To better understand the causes of air pollution, the pollutants can be categorized into 3 separate types, natural, industrial and automotive.

Natural Pollutants

Natural pollution has been present on earth since before man appeared and continues to be a factor when discussing air pollution, although it causes only a small percentage of the overall pollution problem. It is the direct result of decaying organic matter, wind born smoke and particulates from such natural events as plain and forest fires (ignited by heat or lightning), volcanic ash, sand and dust which can spread over a large area of the countryside.

Such a phenomenon of natural pollution has been seen in the form of volcanic eruptions, with the resulting plume of smoke, steam and volcanic ash blotting out the sun's rays as it spreads and rises higher into the atmosphere. As it travels into the atmosphere the upper air currents catch and carry the smoke and ash, while condensing the steam back into water vapor. As the water vapor, smoke and ash travel on their journey, the smoke dissipates into the atmosphere while the ash and moisture settle back to earth in a trail hundreds of miles long. In some cases, lives are lost and millions of dollars of property damage result.

Industrial Pollutants

Industrial pollution is caused primarily by industrial processes, the burning of coal, oil and natural gas, which in turn produce smoke and fumes. Because the burning fuels contain large amounts of sulfur, the principal ingredients of smoke and fumes are sulfur dioxide and particulate matter. This type of pollutant occurs most severely during still, damp and cool weather, such as at night. Even in its less severe form, this pollutant is not confined to just cities. Because of air movements, the pollutants move for miles over the surrounding countryside, leaving in its path a barren and unhealthy environment for all living things.

Working with Federal, State and Local mandated regulations and by carefully monitoring emissions, big business has greatly reduced the amount of pollutant introduced from its industrial sources, striving to obtain an acceptable level. Because of the mandated industrial emission clean up, many land areas and streams in and around the cities that were formerly barren of vegetation and life, have now begun to move back in the direction of nature's intended balance.

Automotive Pollutants

The third major source of air pollution is automotive emissions. The emissions from the internal combustion engines were not an appreciable problem years ago because of the small number of registered vehicles and the nation's small highway system. However, during the early 1950's, the trend of the American people was to move from the cities to the surrounding suburbs. This caused an immediate problem in transportation because the majority of suburbs were not afforded mass transit conveniences. This lack of transportation created an attractive market for the automobile manufacturers, which resulted in a dramatic increase in the number of vehicles produced and sold, along with a marked increase in highway construction between cities and the suburbs. Multi-vehicle families emerged with a growing emphasis placed on an individual vehicle per family member. As the increase in vehicle ownership and usage occurred, so did pollutant levels in and around the cities, as suburbanites drove daily to their businesses and employment, returning at the end of the day to their homes in the suburbs.

It was noted that a smoke and fog type haze was being formed and at times, remained in suspension over the cities, taking time to dissipate. At first this "smog," derived from the words "smoke" and "fog," was thought to result from industrial pollution but it was determined that automobile emissions shared the blame. It was discovered that when normal automobile emissions were exposed to sunlight for a period of time, complex chemical reactions would take place.

It is now known that smog is a photo chemical layer which develops when certain oxides of nitrogen (NOx) and unburned hydrocarbons (HC) from automobile emissions are exposed to sunlight. Pollution was more severe when smog would become stagnant over an area in which a warm layer of air settled over the top of the cooler air mass, trapping and holding the cooler mass at ground level. The trapped cooler air would keep the emissions from being dispersed and diluted through normal air flows. This type of air stagnation was given the name "Temperature Inversion."

TEMPERATURE INVERSION

In normal weather situations, surface air is warmed by heat radiating from the earth's surface and the sun's rays. This causes it to rise upward, into the atmosphere. Upon rising it will cool through a convection type heat exchange with the cooler upper air. As warm air rises, the surface pollutants are carried upward and dissipated into the atmosphere.

When a temperature inversion occurs, we find the higher air is no longer cooler, but is warmer than the surface air, causing the cooler surface air to become trapped. This warm air blanket can extend from above ground level to a few hundred or even a few thousand feet into the air. As the surface air is trapped, so are the pollutants, causing a severe smog condition. Should this stagnant air mass extend to a few thousand feet high, enough air movement with the inversion takes place to allow the smog layer to rise above ground level but the pollutants still cannot dissipate. This inversion can remain for days over an area, with the smog level only rising or lowering from ground level to a few hundred feet high. Meanwhile, the pollutant levels increase, causing eye irritation, respiratory problems, reduced visibility, plant damage and in some cases, even disease.

This inversion phenomenon was first noted in the Los Angeles, California area. The city lies in terrain resembling a basin and with certain weather conditions, a cold air mass is held in the basin while a warmer air mass covers it like a lid.

Because this type of condition was first documented as prevalent in the Los Angeles area, this type of trapped pollution was named Los Angeles Smog, although it occurs in other areas where a large concentration of automobiles are used and the air remains stagnant for any length of time.

HEAT TRANSFER

Consider the internal combustion engine as a machine in which raw materials must be placed so a finished product comes out. As in any machine operation, a certain amount of wasted material is formed. When we relate this to the internal combustion engine, we find that through the input of air and fuel, we obtain power during the combustion process to drive the vehicle. The by-product or waste of this power is, in part, heat and exhaust gases with which we must dispose.

The heat from the combustion process can rise to over 4000°F (2204°C). The dissipation of this heat is controlled by a ram air effect, the use of cooling fans to cause air flow and a liquid coolant solution surrounding the combustion area to transfer the heat of combustion through the cylinder walls and into the coolant. The coolant is then directed to a thin-finned, multi-tubed radiator, from which the excess heat is transferred to the atmosphere by 1 of the 3 heat transfer methods, conduction, convection or radiation.

The cooling of the combustion area is an important part in the control of exhaust emissions. To understand the behavior of the combustion and transfer of its heat, consider the air/fuel charge. It is ignited and the flame front burns progressively across the combustion chamber until the burning charge reaches the cylinder walls. Some of the fuel in contact with the walls is not hot enough to burn, thereby snuffing out or quenching the combustion process. This leaves unburned fuel in the combustion chamber. This unburned fuel is then forced out of the cylinder and into the exhaust system, along with the exhaust gases.

Many attempts have been made to minimize the amount of unburned fuel in the combustion chambers due to quenching, by increasing the coolant temperature and lessening the contact area of the coolant around the combustion area. However, design limitations within the combustion chambers prevent the complete burning of the air/fuel charge, so a certain amount of the unburned fuel is still expelled into the exhaust system, regardless of modifications to the engine.

AUTOMOTIVE EMISSIONS

Before emission controls were mandated on internal combustion engines, other sources of engine pollutants were discovered along with the exhaust emissions. It was determined that engine combustion exhaust produced approximately 60 percent of the total emission pollutants, fuel evaporation from the fuel tank and carburetor vents produced 20 percent, with the final 20 percent being produced through the crankcase as a by-product of the combustion process.

Exhaust Gases

The exhaust gases emitted into the atmosphere are a combination of burned and unburned fuel. To understand the exhaust emission and its composition, we must review some basic chemistry.

When the air/fuel mixture is introduced into the engine, we are mixing air, composed of nitrogen (78 percent), oxygen (21 percent) and other gases (1 percent) with the fuel, which is 100 percent hydrocarbons (HC), in a semi-controlled ratio. As the combustion process is accomplished, power is produced to move the vehicle while the heat of combustion is transferred to the cooling system. The exhaust gases are then composed of nitrogen, a diatomic gas (N_2), the same as was introduced in the engine, carbon dioxide (CO_2), the same gas that is used in beverage carbonation, and water vapor (H_2O). The nitrogen (N_2), for the most part, passes through the engine unchanged, while the oxygen (O_2) reacts (burns) with the hydrocarbons (HC) and produces the carbon dioxide (CO_2) and the water vapors (H_2O). If this chemical process would be the only process to take place, the exhaust emissions would be harmless. However, during the combustion process, other compounds are formed which are considered dangerous. These pollutants are hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), oxides of sulfur (SOx) and engine particulates.

HYDROCARBONS

Hydrocarbons (HC) are essentially fuel which was not burned during the combustion process or which has escaped into the atmosphere through fuel evaporation. The main sources of incomplete combustion are rich air/fuel mixtures, low engine temperatures and improper spark timing. The main sources of hydrocarbon emission through fuel evaporation on most vehicles used to be the vehicle's fuel tank and carburetor float bowl.

To reduce combustion hydrocarbon emission, engine modifications were made to minimize dead space and surface area in the combustion chamber. In addition, the air/fuel mixture was made more lean through the improved control which feedback carburetion and fuel injection offers and by the addition of external controls to aid in further combustion of the hydrocarbons outside the engine. Two such methods were the addition of air injection systems, to inject fresh air into the exhaust manifolds and the installation of catalytic converters, units that are able to burn traces of hydrocarbons without affecting the internal combustion process or fuel economy.

To control hydrocarbon emissions through fuel evaporation, modifications were made to the fuel tank to allow storage of the fuel vapors during periods of engine shut-down. Modifications were also made to the air intake system so that at specific times during engine operation, these vapors may be purged and burned by blending them with the air/fuel mixture.

CARBON MONOXIDE

Carbon monoxide is formed when not enough oxygen is present during the combustion process to convert carbon (C) to carbon dioxide (CO_2). An increase in the carbon monoxide (CO) emission is normally accompanied by an increase in the hydrocarbon (HC) emission because of the lack of oxygen to completely burn all of the fuel mixture.

Carbon monoxide (CO) also increases the rate at which the photo chemical smog is formed by speeding up the conversion of nitric oxide (NO) to nitrogen dioxide (NO_2). To accomplish this, carbon monoxide (CO) combines with oxygen (O_2) and nitric oxide (NO) to produce carbon dioxide (CO_2) and nitrogen dioxide (NO_2). ($CO + O_2 + NO = CO_2 + NO_2$).

The dangers of carbon monoxide, which is an odorless and colorless toxic gas are many. When carbon monoxide is inhaled into the lungs and passed into the blood stream, oxygen is replaced by the carbon monoxide in the red blood cells, causing a reduction in the amount of oxygen supplied to the many parts of the body. This lack of oxygen causes headaches, lack of coordination, reduced mental alertness and, should the carbon monoxide concentration be high enough, death could result.

NITROGEN

Normally, nitrogen is an inert gas. When heated to approximately 2500°F (1371°C) through the combustion process, this gas becomes active and causes an increase in the nitric oxide (NO) emission.

Oxides of nitrogen (NOx) are composed of approximately 97-98 percent nitric oxide (NO). Nitric oxide is a colorless gas but when it is passed into the atmosphere, it combines with oxygen and forms nitrogen dioxide (NO_2). The nitrogen dioxide then combines with chemically active hydrocarbons (HC) and when in the presence of sunlight, causes the formation of photo-chemical smog.

Ozone

To further complicate matters, some of the nitrogen dioxide (NO_2) is broken apart by the sunlight to form nitric oxide and oxygen. (NO_2 + sunlight = NO + O). This single atom of oxygen then combines with diatomic (meaning 2 atoms) oxygen (O_2) to form ozone (O_3). Ozone is one of the smells associated with smog. It has a pungent and offensive odor, irritates the eyes and lung tissues, affects the growth of plant life and causes rapid deterioration of rubber products. Ozone can be formed by sunlight as well as electrical discharge into the air.

The most common discharge area on the automobile engine is the secondary ignition electrical system, especially when inferior quality spark plug cables are used. As the surge of high voltage is routed through the secondary cable, the circuit builds up an electrical field around the wire, which acts upon the oxygen in the surrounding air to form the ozone. The faint glow along the cable with the engine running that may be visible on a dark night, is called the "corona discharge." It is the result of the electrical field passing from a high along the cable, to a low in the surrounding air, which forms the ozone gas. The combination of corona and ozone has been a major cause of cable deterioration. Recently, different and better quality insulating materials have lengthened the life of the electrical cables.

Although ozone at ground level can be harmful, ozone is beneficial to the earth's inhabitants. By having a concentrated ozone layer called the "ozonosphere," between 10 and 20 miles (16-32 km) up in the atmosphere, much of the ultra violet radiation from the sun's rays are absorbed and screened. If this ozone layer were not present, much of the earth's surface would be burned, dried and unfit for human life.

OXIDES OF SULFUR

Oxides of sulfur (SOx) were initially ignored in the exhaust system emissions, since the sulfur content of gasoline as a fuel is less than 1/10 of 1 percent. Because of this small amount, it was felt that it contributed very little to the overall pollution problem. However, because of the difficulty in solving the sulfur emissions in industrial pollutions and the introduction of catalytic converter to the automobile exhaust systems, a change was mandated. The automobile exhaust system, when equipped with a catalytic converter, changes the sulfur dioxide (SO_2) into the sulfur trioxide (SO_3).

When this combines with water vapors (H_2O), a sulfuric acid mist (H_2SO_4) is formed and is a very difficult pollutant to handle since it is extremely corrosive. This sulfuric acid mist that is formed, is the same mist that rises from the vents of an automobile battery when an active chemical reaction takes place within the battery cells.

When a large concentration of vehicles equipped with catalytic converters are operating in an area, this acid mist may rise and be distributed over a large ground area causing land, plant, crop, paint and building damage.

PARTICULATE MATTER

A certain amount of particulate matter is present in the burning of any fuel, with carbon constituting the largest percentage of the particulates. In gasoline, the remaining particulates are the burned remains of the various other compounds used in its manufacture. When a gasoline engine is in good internal condition, the particulate emissions are low but as the engine wears internally, the particulate emissions increase. By visually inspecting the tail pipe emissions, a determination can be made as to where an engine defect may exist. An engine with light gray or blue smoke emitting from the tail pipe normally indicates an increase in the oil consumption through burning due to internal engine wear. Black smoke would indicate a defective fuel delivery system, causing the engine to operate in a rich mode. Regardless of the color of the smoke, the internal part of the engine or the fuel delivery system should be repaired to prevent excess particulate emissions.

Diesel and turbine engines emit a darkened plume of smoke from the exhaust system because of the type of fuel used. Emission control regulations are mandated for this type of emission and more stringent measures are being used to prevent excess emission of the particulate matter. Electronic components are being introduced to control the injection of the fuel at precisely the proper time of piston travel, to achieve the optimum in fuel ignition and fuel usage. Other particulate after-burning components are being tested to achieve a cleaner emission.

Good grades of engine lubricating oils should be used, which meet the manufacturers specification. Cut-rate oils can contribute to the particulate emission problem because of their low flash or ignition temperature point. Such oils burn prematurely during the combustion process causing emission of particulate matter.

The cooling system is an important factor in the reduction of particulate matter. The optimum combustion will occur, with the cooling system operating at a temperature specified by the manufacturer. The cooling system must be maintained in the same manner as the engine oiling system, as each system is required to perform properly in order for the engine to operate efficiently for a long time.

Crankcase Emissions

Crankcase emissions are made up of water, acids, unburned fuel, oil fumes and particulates. These emissions are classified as hydrocarbons (HC) and are formed by the small amount of unburned, compressed air/fuel mixture entering the crankcase from the combustion area (between the cylinder walls and piston rings) during the compression and power strokes. The head of the compression and combustion help to form the remaining crankcase emissions.

Since the first engines, crankcase emissions were allowed into the atmosphere through a road draft tube, mounted on the lower side of the engine block. Fresh air came in through an open oil filler cap or breather. The air passed through the crankcase mixing with blow-by gases. The motion of the vehicle and the air blowing past the open end of the road draft tube caused a low pressure area (vacuum) at the end of the tube. Crankcase emissions were simply drawn out of the road draft tube into the air.

To control the crankcase emission, the road draft tube was deleted. A hose and/or tubing was routed from the crankcase to the intake manifold so the blow-by emission could be burned with the air/fuel mixture. However, it was found that intake manifold vacuum, used to draw the crankcase emissions into the manifold, would vary in strength at the wrong time and not allow the proper emission flow. A regulating valve was needed to control the flow of air through the crankcase.

Testing, showed the removal of the blow-by gases from the crankcase as quickly as possible, was most important to the longevity of the engine. Should large accumulations of blow-by gases remain and condense, dilution of the engine oil would occur to form water, soots, resins, acids and lead salts, resulting in the formation of sludge and varnishes. This condensation of the blow-by gases occurs more frequently on vehicles used in numerous starting and stopping conditions, excessive idling and when the engine is not allowed to attain normal operating temperature through short runs.

Evaporative Emissions

Gasoline fuel is a major source of pollution, before and after it is burned in the automobile engine. From the time the fuel is refined, stored, pumped and transported, again stored until it is pumped into the fuel tank of the vehicle, the gasoline gives off unburned hydrocarbons (HC) into the atmosphere. Through the redesign of storage areas and venting systems, the pollution factor was diminished, but not eliminated, from the refinery standpoint. However, the automobile still remained the primary source of vaporized, unburned hydrocarbon (HC) emissions.

Fuel pumped from an underground storage tank is cool but when exposed to a warmer ambient temperature, will expand. Before controls were mandated, an owner might fill the fuel tank with fuel from an underground storage tank and park the vehicle for some time in warm area, such as a parking lot. As the fuel would warm, it would expand and should no provisions or area be provided for the expansion, the fuel would spill out of the filler neck and onto the ground, causing hydrocarbon (HC) pollution and creating a severe fire hazard. To correct this condition, the vehicle manufacturers added overflow plumbing and/or gasoline tanks with built in expansion areas or domes.

However, this did not control the fuel vapor emission from the fuel tank. It was determined that most of the fuel evaporation occurred when the vehicle was stationary and the engine not operating. Most vehicles carry 5-25 gallons (19-95 liters) of gasoline. Should a large concentration of vehicles be parked in one area, such as a large parking lot, excessive fuel vapor emissions would take place, increasing as the temperature increases.

To prevent the vapor emission from escaping into the atmosphere, the fuel systems were designed to trap the vapors while the vehicle is stationary, by sealing the system from the atmosphere. A storage system is used to collect and hold the fuel vapors from the carburetor (if equipped) and the fuel tank when the engine is not operating. When the engine is started, the storage system is then purged of the fuel vapors, which are drawn into the engine and burned with the air/fuel mixture.

ENGINE EMISSION CONTROLS

On gasoline engines, there are three sources of automotive pollutants: crankcase fumes, exhaust gasses, and gasoline evaporation. The pollutants formed from these substances fall into three categories: unburned hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx). The equipment used to limit these pollutants is called emission control equipment. This equipment ranges from the inherent internal design of the engine (combustion chamber, heads, valves, camshaft, etc) to external additive pieces such as temperature activated vacuum valves, solenoids, relays and computers. As the emission laws of the U.S. and other nations become stiffer, emission control systems change year-to-year to maintain the required balance of vehicle performance and driveability as well as reduced emissions.

Due to varying state, federal, and provincial regulations, specific emission control equipment has been devised for different pollution sources. For the years covered by this manual, U.S. emission equipment is divided into two categories: California and 49 State. In this section, the term: "California" applies only to cars originally built to be sold in California. In most cases, California emissions equipment is not shared with equipment installed on cars built to be sold in the other 49 States. In 1986, Volvo began phasing out the California designation; in 1987, all cars sold were "50 state" certified, although some models built to be sold in Canada remained different from U.S. versions.

Since diesel engines use a completely different principle of combustion (compression fired rather than spark fired), almost all of the emission control is designed into the construction of the engine. While diesel exhaust is more visible, it actually contains fewer atmospheric pollutants than a gasoline engine's exhaust. The great bulk of diesel exhaust is particulate carbon-soot-which quickly settles out of the air.

The only serviceable emission control on the diesel engine is the positive crankcase ventilation hose located between the valve cover and the intake manifold.

Positive Crankcase Ventilation (PCV) System

OPERATION

Blow-by gasses, combustion gasses that squeeze past the piston rings, tend to collect in the bottom of the engine and, if not vented, will build pressure inside the crankcase until they force their way out. These gasses usually exit through a gasket or an oil seal, creating an oil leak. On older cars, a simple breather pipe was used to vent the blow-by gasses into the atmosphere. This method cannot be used today because blow-by gasses are air pollutants.

On all of the Volvos covered in this book, a PCV system is used which routes the blow-by gasses into the air cleaner or intake manifold where they are burned with the air/fuel mixture.

SERVICING THE PCV SYSTEM

➧ See Figures 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10

Although the gasses build up at the bottom of the engine, the pressure is distributed throughout the inside of the engine. It is easiest to vent them at the top of the engine and conduct them back to the air intake system. For this reason, look for the hoses which run to the valve cover(s) on top of the engine. They are usually found close to the oil filler cap.

Carefully remove the hoses from their fittings one at a time. You are dealing with plastic and/or rubber hoses which have been subjected to engine heat and fumes; they may be brittle or stuck in place. Make sure all hoses and PCV valve nipples are clean and not damaged. Check hoses for blockage and make sure the flame protector, found on some cars after 1983, is not blocked. Replace any torn or disintegrating hoses with

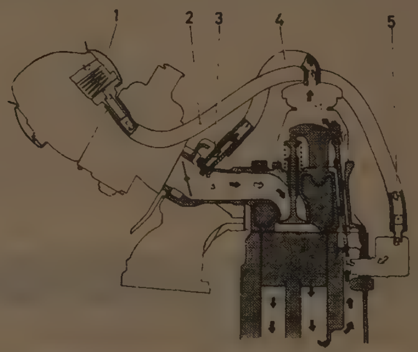


Fig. 1 Cutaway view of the common PCV system — B20B engine shown

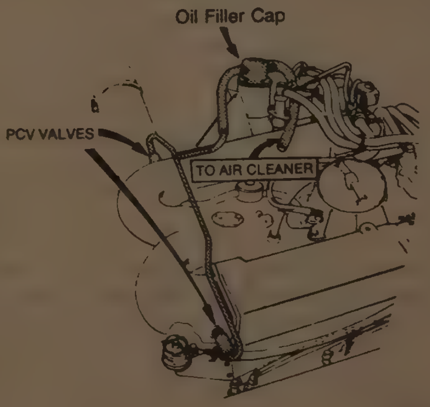
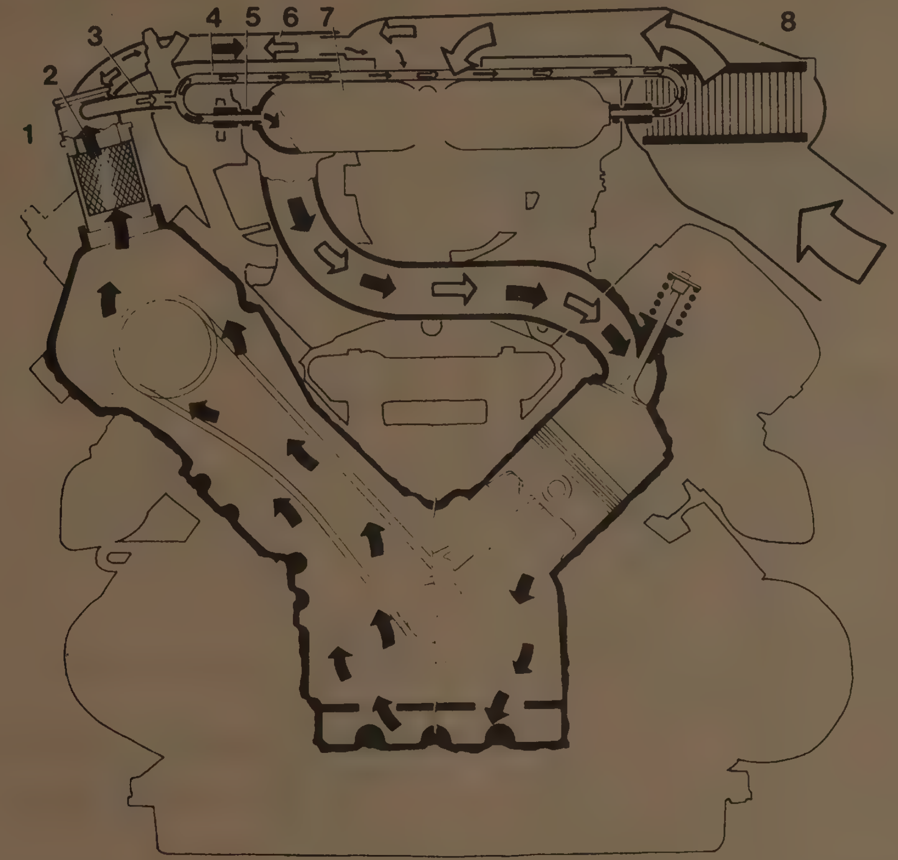


Fig. 2 Dual PCV valves and hose routing — B27F engine shown, B28F engine similar



1. Oil trap
2. Flame guard
3. Hose, channeling crankcase fumes to the intake manifold
4. Distributor pipe
5. Nipple with orifice
6. Hose, channeling:
    - fresh air from the air cleaner to the crankcase (idle)
    - crankcase fumes to the air cleaner (cruising speeds)
7. Intake manifol
8. Air cleaner.

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Fig. 3 Crankcase ventilation system — B27F, B28F and B280F engines

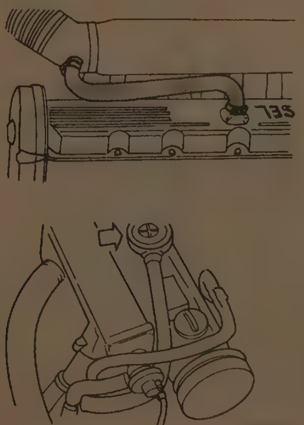

Fig. 4 Diesel PCV systems — upper: D24 engine; lower: D24T engine

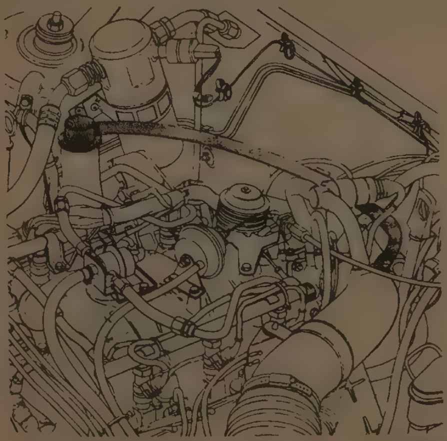

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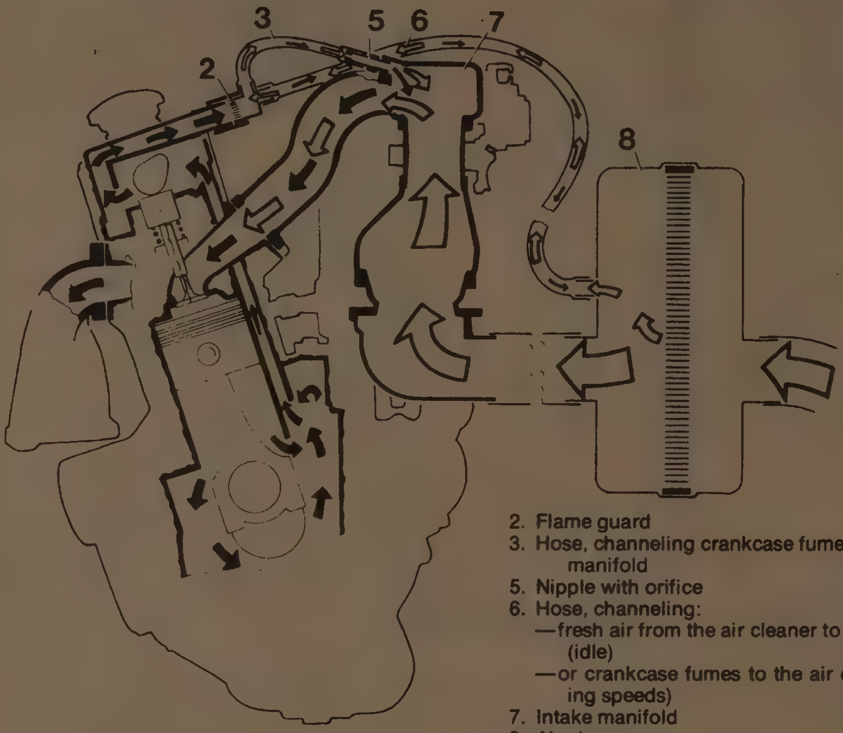
Fig. 5 PCV system hose routing — B280F engine



2. Flame guard
3. Hose, channeling crankcase fumes to the intake manifold
5. Nipple with orifice
6. Hose, channeling:
   - —fresh air from the air cleaner to the crankcase (idle)
   - —or crankcase fumes to the air cleaner (cruising speeds)
7. Intake manifold
8. Air cleaner

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Fig. 6 Cutaway view of the crankcase ventilation system — B21, B23 and B230 engines

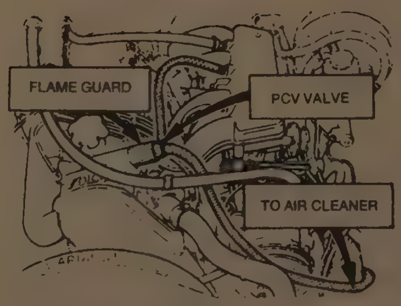

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Fig. 7 PCV system — B21F engines

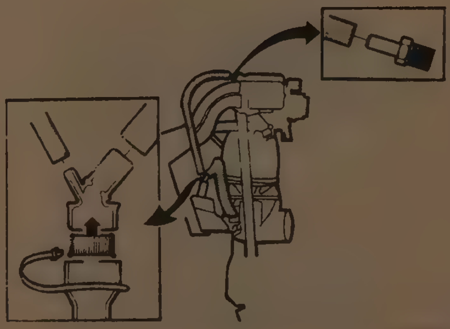

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Fig. 8 PCV system — B230F engine

heat treated, preferably factory replacement, hose. The PCV nipple(s) in the intake manifold, the flame guard and the oil trap should be removed and cleaned every 12,000-15,000 miles (19,324-24,155 km) on cars so equipped. The PCV nipple may need replacement at 60,000 miles (96,618 km).

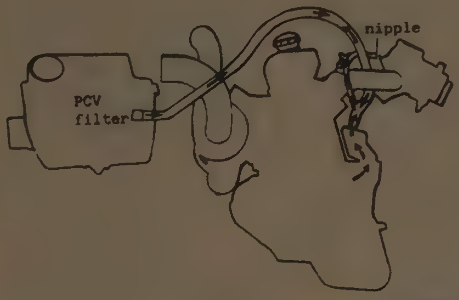


Fig. 9 PCV system — B230F turbo engine

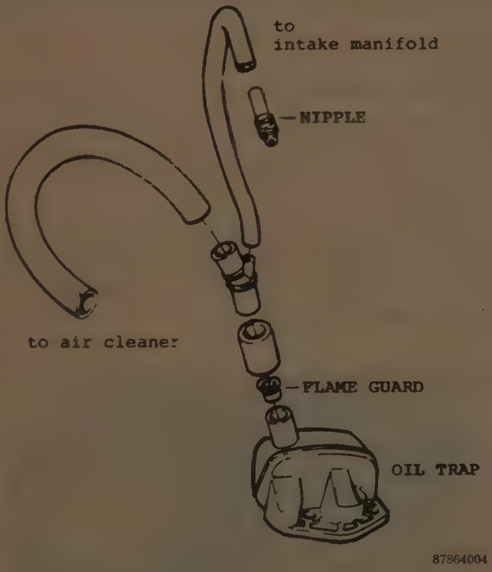


Fig. 10 Exploded view of the PCV system — B21FT engines

Evaporative Control System (Charcoal Canister)

OPERATION

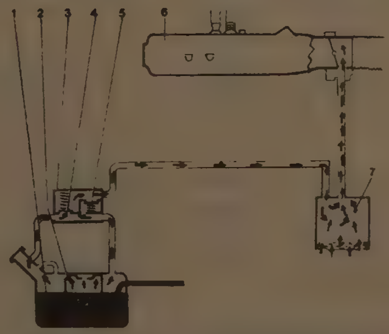
➧ See Figures 11 and 12

All 1970 and later Volvos are equipped with an evaporative control system to prevent fuel vapors in the fuel tank and (in carbureted models) the float chambers from escaping into the atmosphere. An expansion tank above the fuel tank provides for thermal expansion of fuel vapors in warm weather. Those vapors which do not condense and return to the fuel tank are displaced and drawn into an activated charcoal canister in the engine compartment.

When the engine is at idle or is shut off, the charcoal canister absorbs and stores the vapors from both the tank and the carburetor. Throttling the engine causes the vapors to be drawn out of the canister into the air/fuel mixture bound for the engine. The vapors enter the engine through the intake manifold and are burned in the combustion chambers.

On carbureted models, the float chamber vapors are diverted from the canister to the air cleaner upon acceleration. As a result of these fumes being vented to the air cleaner, an overly rich (proportionally too much fuel for the amount of air present) fuel mixture may develop, leading to starting difficulties-especially in warm weather. A hot-start valve is located between the float chamber and the air cleaner on carbureted models which returns the vapors to the charcoal canister until the engine can handle the extra-rich mixture.

On 1974 and later models, the expansion tank was relocated inside the fuel tank and an equalizing or balance valve is used to regulate pressure buildup in the fuel tank. When the expanding fuel vapors create too much pressure in the tank, the



1. Fuel tank
2. Expansion tank
3. Inlet duct
4. Venting filter
5. Pressure reduction valve
6. Inlet manifold
7. Charcoal canister

Fig. 11 Details of the fuel evaporative system — fuel injected engines

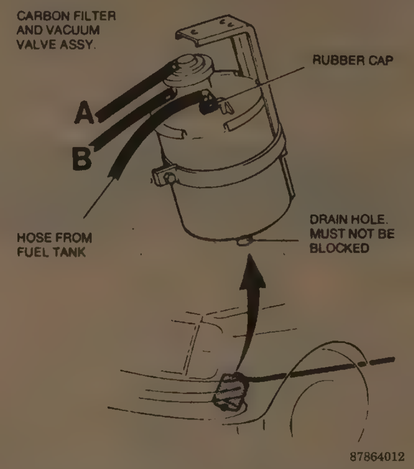

CARBON FILTER AND VACUUM VALVE ASSY.
RUBBER CAP
A
B
HOSE FROM FUEL TANK
DRAIN HOLE. MUST NOT BE BLOCKED
87864012

Fig. 12 Typical evaporative control canister mounting

valve opens and allows the vapors to be fed into the charcoal canister. When too much vacuum is present in the fuel tank (due to sudden cooling or low fuel level) a second valve opens and allows air from the venting filter back into the fuel tank to prevent the tank from collapsing. The equalizing valve also prevents fuel from entering the vapor line during hard cornering.

SERVICE

See Figures 13 and 14

The charcoal canister is located in the engine compartment on all models except the 1800E and 1800ES, on which the canister is located under the left front fender.

On 1970-73 models the canister has a removable foam plastic filter in the bottom which should be replaced every 24,000 miles (38,647 km). The filter is exposed and can be removed from the bottom of the canister when the canister is removed from the car. On 1974-78 models, the entire canister should be replaced every 45,000-48,000 miles (72,464-77,295 km), depending on the model and year of the vehicle. On 1979 and later models, the canister is non serviceable and requires no maintenance, other than checking lines for kinks or obstructions. If the car has experienced a severe fuel-related problem (continued flooding, polluted or incorrect fuel, etc.) the canister may need to be replaced. It cannot be cleaned or reconditioned.

➡Before attempting to remove or service the charcoal canister, label each hose and its matching port. Hose placement is critical to the proper operation of the engine. Make sure hoses are reinstalled in their proper place and held firmly with clamps.

To remove the canister on 1970-73 models, disconnect the hoses from the top and side of the canister, loosen the canister bracket bolt and slide the canister out. On 1974 and later models, pull the valve with its hose off the top of the canister, remove the other hoses (if equipped), loosen the clamp screw and slide the canister out of its bracket.

Fig. 14 Lower the canister and bracket, then disconnect and label the rest of the lines

The hoses should be routinely checked for cracks, kinks and restrictions. The ends of the vacuum hoses can become brittle and leak at their connections. The lines to the fuel tank should also be checked periodically for any crushing or kinking under the car, and always after any impact to the underside of the car from solid objects or ice.

Exhaust Gas Recirculation (EGR) System

OPERATION

See Figures 15, 16 and 17

➡All 1980 and later U.S. models are not equipped with EGR systems.

In order to control emissions of NOx, all 1973-74 140 series, 164E and 1800ES models with automatic transmissions, as well as 1975 164, 240 and 260 series, were equipped with an exhaust gas recirculation system.

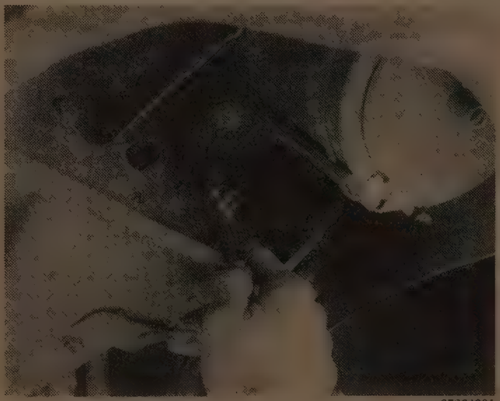


Fig. 13 After you have disconnected and labeled the lines, unbolt and remove the bracket. Hold the canister with your other hand so that it will not fall

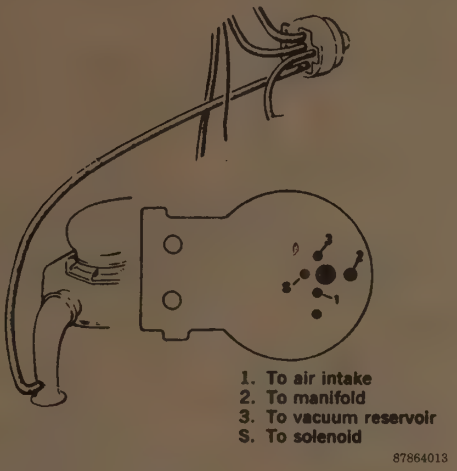

1. To air intake
2. To manifold
3. To vacuum reservoir
S. To solenoid
87864013

Fig. 15 Cutaway view of the vacuum amplifier — B20 engines

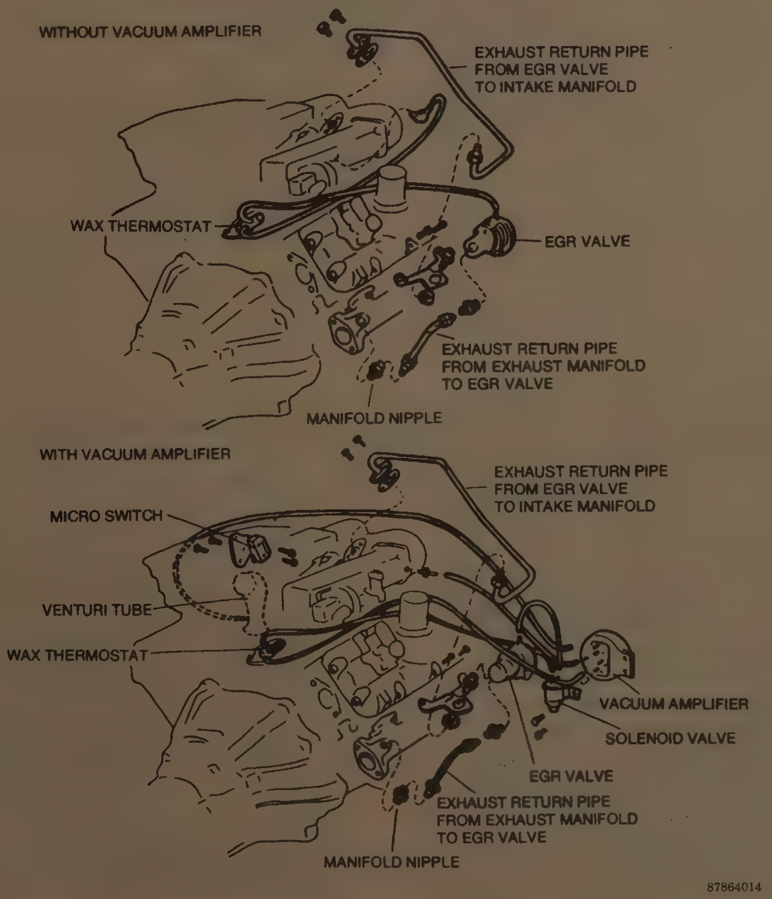

WITHOUT VACUUM AMPLIFIER
EXHAUST RETURN PIPE FROM EGR VALVE TO INTAKE MANIFOLD
WAX THERMOSTAT
EGR VALVE
EXHAUST RETURN PIPE FROM EXHAUST MANIFOLD TO EGR VALVE
MANIFOLD NIPPLE
WITH VACUUM AMPLIFIER
EXHAUST RETURN PIPE FROM EGR VALVE TO INTAKE MANIFOLD
MICRO SWITCH
VENTURI TUBE
WAX THERMOSTAT
VACUUM AMPLIFIER
SOLENOID VALVE
EGR VALVE
EXHAUST RETURN PIPE FROM EXHAUST MANIFOLD TO EGR VALVE
MANIFOLD NIPPLE
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Fig. 16 EGR system for B27F and B28F engines — upper: without vacuum amplifier; lower: with vacuum amplifier

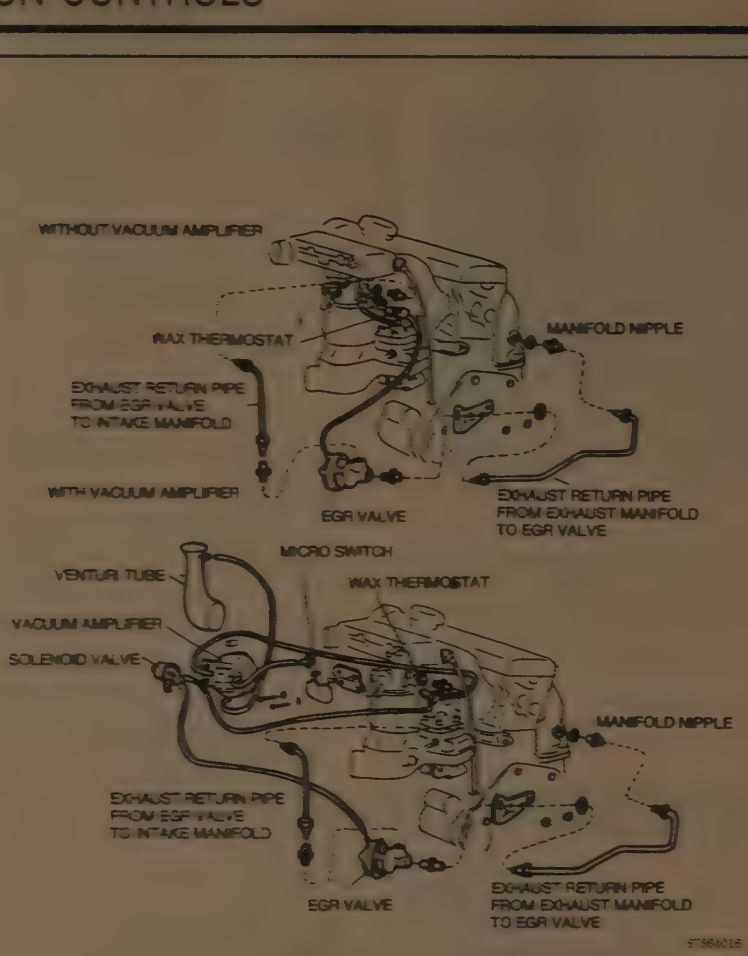

WITHOUT VACUUM AMPLIFIER
WAX THERMOSTAT
MANIFOLD NIPPLE
EXHAUST RETURN PIPE FROM EGR VALVE TO INTAKE MANIFOLD
WITH VACUUM AMPLIFIER
EGR VALVE
EXHAUST RETURN PIPE FROM EXHAUST MANIFOLD TO EGR VALVE
MICRO SWITCH
VENTURI TUBE
WAX THERMOSTAT
VACUUM AMPLIFIER
SOLENOID VALVE
MANIFOLD NIPPLE
EXHAUST RETURN PIPE FROM EGR VALVE TO INTAKE MANIFOLD
EGR VALVE
EXHAUST RETURN PIPE FROM EXHAUST MANIFOLD TO EGR VALVE
87964016

Fig. 17 EGR system for B21 and B23 engines — upper: without vacuum amplifier; lower: with vacuum amplifier

The system consists of a metering valve (EGR valve), a pipe running from the exhaust manifold to the EGR valve, another pipe running from the valve to the intake manifold, and a vacuum hose running from the EGR valve's diaphragm to the intake manifold in front of the throttle valve(s). The valve permits a regulated amount of exhaust gas to enter the inlet duct and mix with the incoming air/fuel mixture.

The only way the EGR valve will open is when vacuum is applied through its vacuum hose. When vacuum is applied, it raises a diaphragm inside the EGR valve. This diaphragm is connected to a plunger inside the EGR valve housing. When the plunger is open, it allows exhaust gases to pass through the pipe between the valve and the intake manifold. When the exhaust gases mix with the air/fuel charge in the combustion chamber, they act to slightly slow the rapid combustion process and lower the overall combustion chamber temperature. This lower combustion temperature prevents the formation of oxides of nitrogen (NOx).

On 1974-75 B20 engines, 1976 B21 and B27 models sold in California and all later models with EGR valves, the EGR system is modified to improve cold start driveability by the addition of a venturi vacuum amplifier system.

The EGR system with vacuum amplifier works as follows: venturi vacuum at the air intake is used to measure the total air flow. This weak vacuum signal controls the vacuum amplifier which regulates the EGR valve via a solenoid valve. The vacuum amplifier receives inputs both from the strong intake manifold source which is used as a power source, and from the weak air intake source which is to be amplified. The intake vacuum is stored in the vacuum reservoir and is controlled by a check valve in the amplifier. This allows a generous amount of vacuum on tap, regardless of variations in engine manifold vacuum.

The amplifier then continues to supply adequate vacuum at higher speeds and moderate throttle openings, when manifold vacuum normally would drop to an insufficient amount. The EGR system functions as before, except that the exhaust gases are prevented from recirculating at idle and full throttle by a throttle angle sensing micro-switch and an electrically operated solenoid valve, rather than simple vacuum as in 1973. On 1976 and later models, a wax thermostat blocks exhaust gas recirculation until the engine warms to 140°F (60°C).

Beginning with the 1975 model year, all Volvos equipped with an EGR system have a reminder light which is actuated by the odometer at 15,000 mile (24,155 km) intervals. The light may be reset by pressing a white button at the rear of the odometer.

➡Models equipped with the Lambda Sond oxygen sensor system do not have EGR valves. All 1978-80 California models, as well as 1980 and later 49 states models, are not equipped with EGR valves.

SERVICE

Check and clean the system every 12 months/12,000 miles (19,324 km) for 1973-74 vehicles, or 12 months/15,000 miles (24,155 km) for 1975-83 vehicles. Replace the EGR valve, if equipped, every 24 months/24,000 miles (38,647 km) for 1973-74 vehicles, or 24 months/30,000 miles (48,309 km) for 1975-83 vehicles.

CHECKING

All 1973 Models and 1975 164

The EGR valve and piping conducts exhaust gases; for this reason, the system components are exposed to high temperatures, corrosion and soot. It is not uncommon for an EGR valve to become plugged with carbon. When this happens, the valve cannot close completely. Since there are times that recirculation is not desirable, having the valve stick open causes a variety of driveability problems including poor mileage, lack of power and rough idle. Checking the EGR valve and replacing it on schedule should be a part of your routine maintenance plan.

With the engine warmed up and idling, remove the EGR vacuum hose from the valve and plug it (a wooden golf tee works well), then apply vacuum with a hand-held vacuum pump to the vacuum port on the valve. The engine should stumble or stall, indicating the EGR valve is open. If not, replace the EGR valve.

1974 140 Series and 1975 240 Series

➧ See Figure 18

1. Start the engine and let it idle.
2. Remove the air intake hose from the vacuum amplifier at connection number 1.
3. Connect a vacuum pump or other suction device to outlet number 1 on the vacuum amplifier.
4. Apply vacuum: the EGR valve should NOT open (the idle should not stumble or the engine stall).
5. Check that the system holds a vacuum for about 10 seconds.
6. With the vacuum still applied to outlet number 1 on the vacuum amplifier, disconnect the wire from the micro-switch at the throttle linkage. The EGR valve should open, so that the engine runs poorly or stalls. The micro-switch "tells" the system that the engine is at idle: by disconnecting the switch, the system reacts as if the engine were under acceleration. The EGR system engages.
7. Reconnect all components and increase engine speed. Visually check that the EGR valve opens. Drop the engine to idle: the EGR valve should close.
8. To adjust the micro-switch, unplug the micro-switch electrical connection and hook up a test light between the switch and its electrical connection. Turn on the ignition.
9. Back off the adjustment screws on both the micro-switch and the throttle plate. To adjust the throttle plate, turn in its screw until it just touches the stop, then turn it ½ turn more. Secure its locknut.
10. Insert a 0.060 in. (1.5mm) for the 240 series, or a 0.040 in. (1.0mm) for the 140 series, feeler blade under the throttle stop screw. The test light should not light. Turn in the micro-switch screw until the light just turns on. You will hear the switch click. Secure the lock nut, remove the gauge and reconnect the micro-switch wire.

1976-83 Models

Without Vacuum Amplifier

➧ See Figure 19

➡Models equipped with the Lambda Sond oxygen sensor system do not have EGR valves. 1978-80 California models, as well as 1980 and later 49 states models, are not equipped with EGR valves. Therefore, portions of the following procedure may not apply to your vehicle.

1. With the engine cold, check the operation of the wax thermostat. Start the engine and allow it to idle. Manipulate the throttle by hand and check that the EGR valve rod does not move in and out. If it does, the thermostat is faulty. It should not operate the EGR valve until the coolant reaches 130-140°F (54-60°C).
2. With the engine warmed up to normal operating temperature — 176°F (80°C) — check that the EGR valve rod does move in and out then the throttle is opened and closed. If not, the wax thermostat, hoses or EGR valve may be at fault.
3. Stop the engine. Disconnect the vacuum hose from the EGR valve. Blow through the hose. If no air passes, the wax

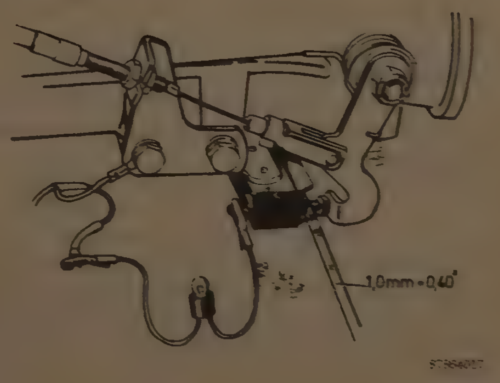


Fig. 18 Adjust the micro-switch to the proper tolerance — B20 engines

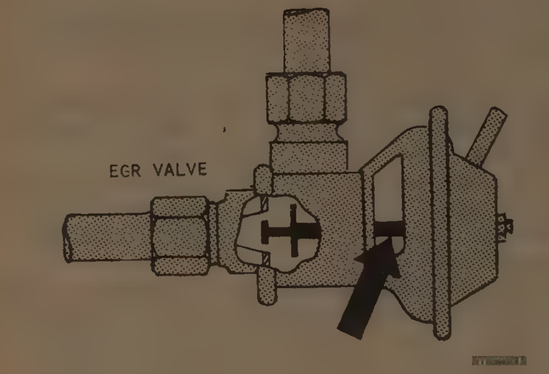


Fig. 19 Check to see if the rod inside the EGR valve moves in and out

thermostat is faulty. If air does pass, either the hose is incorrectly installed or the EGR valve is defective.

4. Finally, connect the EGR vacuum hose and start the engine. Open the throttle to 3000-4000 rpm and then quickly release it. The EGR valve rod should close. If not, replace the EGR valve.

With Vacuum Amplifier

➧ See Figures 20 and 21

➡Use the illustrations to identify the vacuum amplifier; it will be located in the engine compartment.

1. With the engine cold — below 130°F (54°C) — coolant temperature, check the operation of the wax thermostat. Disconnect the vacuum hose at the solenoid valve and disconnect the vacuum hose at the vacuum amplifier connection S. Draw suction on one of the disconnected hoses. If any air passes, one of the hoses has a vacuum leak or the wax thermostat is faulty. Reconnect the hoses.
2. Start the engine and warm up to normal operating temperature (176°F). Stop the engine. Disconnect the two hoses again and draw suction through either of the hoses. This time the thermostat should be open, and air should pass through. If not, replace the wax thermostat.
3. Connect the hoses, then check the throttle position sensing micro-switch, as follows:
    a. Connect a 12V test light in series between the upper wire connector and its upper terminal. Switch the ignition to the **ON** position.
    b. Pull back the throttle lever and insert a 0.060 in. (1.5mm) feeler gauge between the screw and the lever stop. When the lever is released and the throttle screw makes contact with the switch plunger, the test light should illuminate. This indicates that current is reaching the solenoid valve, the micro-switch is activating, and the fuse is good.
    c. Repeat by inserting an 0.080 in. (2mm) feeler gauge between the screw and lever stop. This time, the test light should not light and the throttle screw should not make contact with the switch plunger. Adjust as necessary by loosening the locknut on the stopscrew and adjusting for 0.060 in. (1.5mm) clearance.

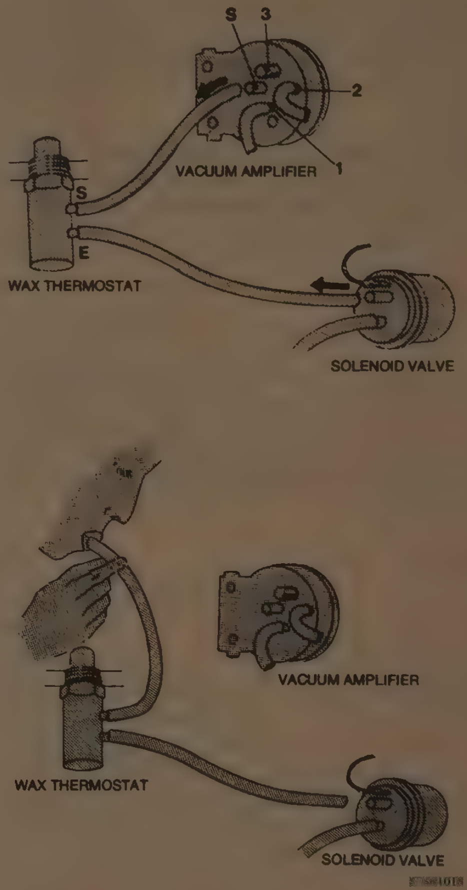


Fig. 20 Check the operation of the wax thermostat — 1976 and later models

➡Models equipped with the Lambda Sond oxygen sensor system do not have EGR valves. 1978-80 California models, as well as 1980 and later 49 states models, are not equipped with EGR valves. Therefore, portions of the following procedure may not apply to your vehicle.

4. Check the solenoid valve next. With the engine running at idle, disconnect the hose from connection 1, and create a vacuum. The EGR valve, if so equipped, should remain closed (no change in rpm). If not, the solenoid valve is defective.
5. With the vacuum pump still connected, and engine idling, check that the vacuum reading does not change for 10 seconds. If the reading changes, this indicates a bad amplifier or leaking hoses.
6. Finally, with the engine idling, increase the rpm while observing the EGR valve (if so equipped). If the EGR valve rod does not open, check for clogged venturi or leaking venturi vacuum hose. After increasing engine speed to about 2500

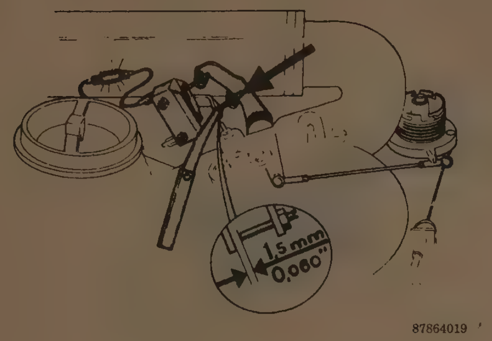


Fig. 21 Use a feeler gauge to check the micro-switch adjustment — B27F engine shown

rpm, suddenly release the throttle and check that the EGR valve rod closes. If it does not, the solenoid valve is faulty.

REMOVAL & INSTALLATION

The EGR valve simply unbolts from the two pipes it connects. Always use two wrenches to free the couplings or you may bend the pipes. If it is necessary to replace the valve, check the part number stamped on the body of the old valve and install an exact match. An incorrect valve may add to the problems you're trying to cure.

The EGR valve may be cleaned by removing it and tapping it lightly with a soft mallet. This dislodges built-up carbon which may be fouling the plunger. Do NOT clean the valve with solvents; this will damage the diaphragm within. Make sure that the ports and pipes are clean and free of carbon. When cleaning or inspecting the EGR valve, hold it in your hand. Mounting it in a vise may deform it and impair its function.

Air Injection Reaction (AIR) System

OPERATION

See Figures 22, 23 and 24

Many 1975 and later Volvos models are equipped with an air injection reactor system. The system injects filtered air into the exhaust manifold in order to reduce emissions of carbon monoxide and hydrocarbons. The oxygen in the air reacts with the exhaust gas and promotes further combustion in the exhaust manifold.

The system consists of an air pump (belt-driven), a diverter valve, an anti-backfiring valve, and a separate air manifold which is attached to the exhaust manifold. Under normal conditions, air is pumped from the air pump via the diverter valve, the backfire valve and the air manifold into the exhaust manifold ports.

The air pump takes in filtered air which is then compressed and discharged to the diverter valve. The diverter valve sends the air through the backfire valve, except during deceleration. The diverter valve also releases some of the air into the atmosphere if the pressure from the pump is too great. The anti-backfire valve is one-way valve which prevents the exhaust gases from flowing back towards the air injection components, but allows the pump air to pass into the air manifold and exhaust manifold.

CHECKING

See Figures 25 and 26

Service the AIR system every 15,000 miles (24,155 km). Make sure the drive belt is in good condition on the air pump. If the belt breaks, the backfire valve must be checked. Make sure all attaching nuts and bolts for the air pump and bracket are secure.

To check the air pump, start the engine and listen for excessive noise from the pump. Remember that the air pump is not completely quiet in normal operation, and it can make a bit of a racket when it's cold. Normally, the noise rises in pitch as engine speed increases. Do not attempt to lubricate or repair the pump: it must be replaced.

To check the backfire valve:

1. Disconnect the hose from the diverter valve.
2. Apply a vacuum to the hose: no air should come through. If it does, replace the backfire valve.

To check the diverter valve:

3. Disconnect and plug the hose from the diverter valve.
4. Run the engine at idle. Air should only be coming out of point A in the illustration.
5. Increase the engine speed to 3000-3500 rpm, then quickly release the throttle. Air should now flow from points B in the illustration. If not, replace the diverter valve.

Pulsair System

SYSTEM CHECK

See Figure 27

Canadian 240 DL Series With B21A, B23E and B21F Engines

Beginning in 1979, Canadian B21A and some B21F engines were fitted with the (then new) Pulsair air injection system. This system was also incorporated into the Canadian B23E engine in 1983. In the Pulsair system, natural pressure pulses in the engine's exhaust system help to draw fresh air into the exhaust system.

Air is then injected into the end of the exhaust port (as in the air pump system) and the oxygen in the injected air aids in the further burning of emissions. The air pump is eliminated in the Pulsair system. Check valves in the system prevent exhaust gases from entering the air cleaner during the pressure pulses.

To check the operation of the system, disconnect the air hose at the air cleaner. With the engine idling, check that air is being drawn in with the palm of your hand and that no backpressure exists.

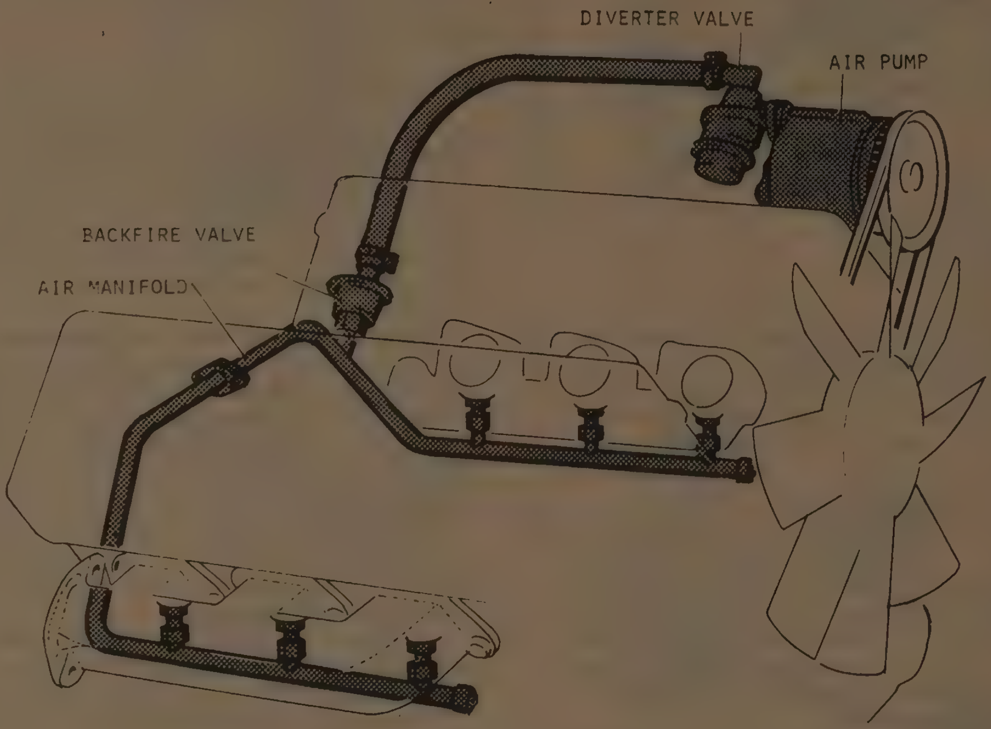
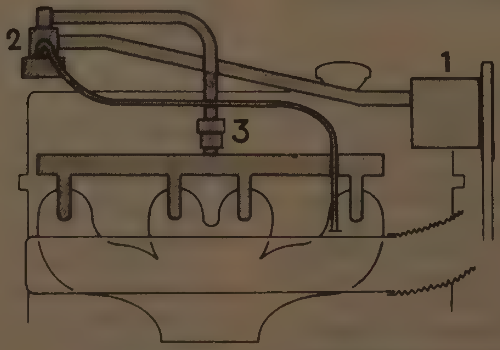

DIVERTER VALVE
AIR PUMP
BACKFIRE VALVE
AIR MANIFOLD
87864020

Fig. 22 Exploded view of the air injection system — B27F engine shown


2
1
3

1. Air pump 2. Diverter valve
3. Backfire valve

87864021

Fig. 23 Common air injection system — B20 engine

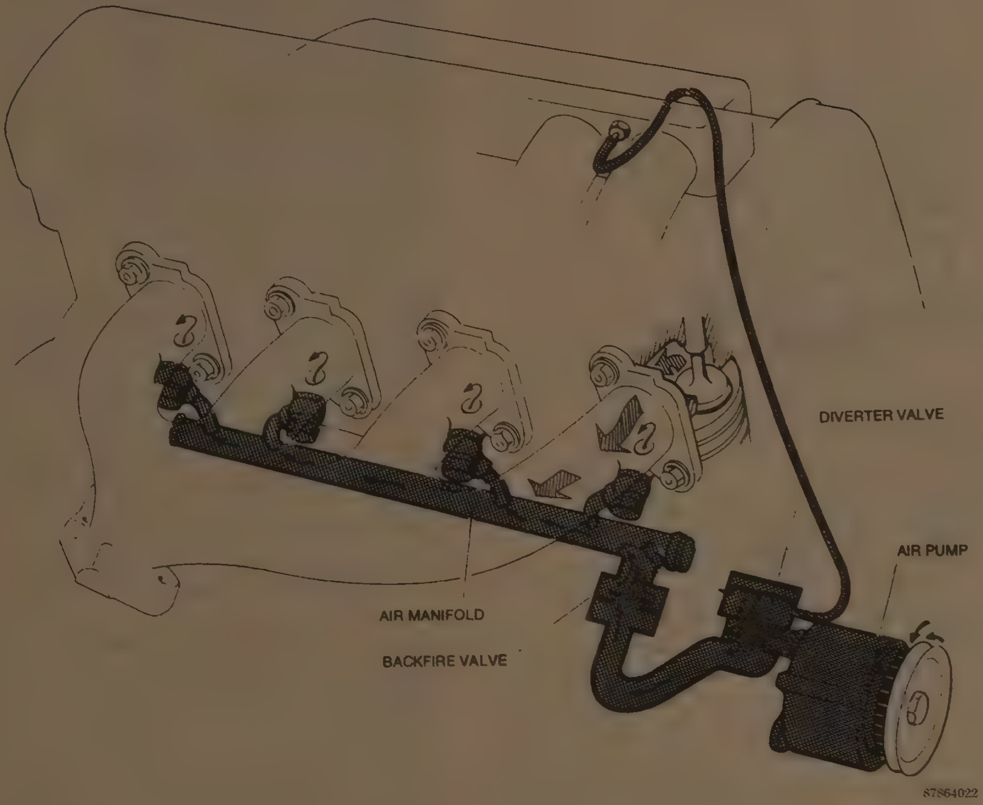

DIVERTER VALVE
AIR PUMP
AIR MANIFOLD
BACKFIRE VALVE
87864022

Fig. 24 Cutaway view of the air injection system — B21F engine

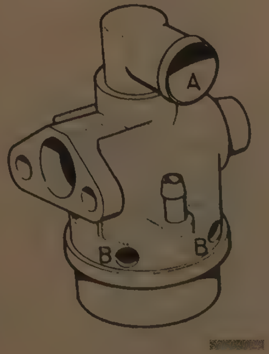


Fig. 25 The diverter valve — 1975 models

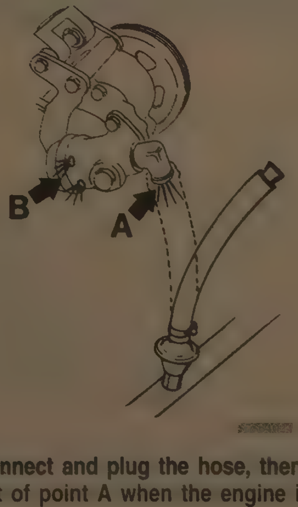


Fig. 26 Disconnect and plug the hose, then make sure air comes out of point A when the engine is idling

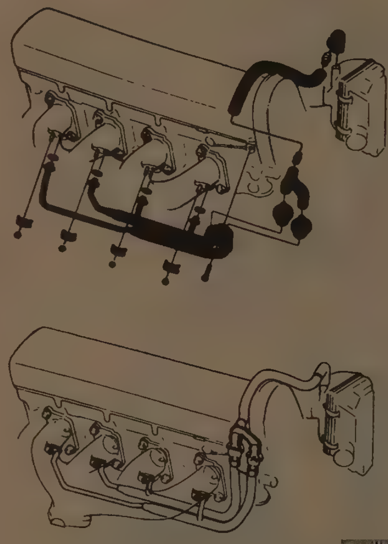


Fig. 27 The Pulsair system as found on the Canadian B21A/F (upper) and B23E models

Catalytic Converter System

See Figure 28

There are two different types of catalytic converters used on Volvos: the oxidation type converter and the three-way converter.

All 1975-76 Volvos manufactured for California, 1975 164 models with manual transmission and overdrive for the 49 states, 1977 49 states 240 series and all 1977 260 series, all 1978 49 states models (except some 242 DL, 242 GT and 262 C models), and all 1979 49 states 240 series models, except the 242 GT, are equipped with the oxidation type converter. The converters are installed in these vehicles to further control emissions of carbon monoxide and hydrocarbons which have resisted the treatment of the air injection system.

The converter is installed in the exhaust system ahead of the muffler. The converter uses platinum and palladium in a substrate or beaded form as the catalyst. The catalyst and the oxygen supplied by the air pump then react with the exhaust gases producing harmless carbon dioxide and water vapor, as well as a minute amount of sulphur dioxide and sulfuric acid.

The converter is designed to last 50,000 miles (80,515 km), as long as leaded gasoline is not used. Since lead is not normally present in today's gasoline, the possibility of lead-related converter damage is remote. However, in the event that leaded gasoline or a lead additive is used, such lead will coat the catalytic substrate or beads, preventing the reaction process and rendering the converter ineffective.

At 15,000 mile (24,155 km) intervals, the retaining bolts for the converter must be checked for tightness. A service reminder light on the dashboard lights at 15,000 mile (24,155 km) intervals. To extinguish the light, press the white reset button at the rear of the odometer.

The 1977 California 240 series, all 1978-80 260 California series, all 1979 49 states 260 series, all 1980 and later (except diesel) models, and the 1979 49 states 242 GT are equipped with three-way catalytic converters.

The purpose of the three-way catalytic converter is to neutralize carbon monoxide, hydrocarbons and oxides of nitrogen in the exhaust gases. The main difference between this converter and the oxidation converter is that the three-way converter is able to process large amounts of oxides of nitrogen (NOx), while the oxidation catalyst cannot.

The operating range of the three-way catalyst is limited to a narrow band around the ideal air/fuel mixture for the engine (14.7:1). To keep the mixture within this narrow band, an oxygen sensor is used to monitor the amount of oxygen in the exhaust gases. The readings from the oxygen sensor are transmitted to the ECU (Emissions control unit or fuel injection computer) which fine tunes the air/fuel mixture being delivered into the engine. Refer to the following Oxygen Sensor Feedback System (Lambda Sond) coverage for more information on the oxygen sensor system.

As with the oxidation catalytic converter, the use of leaded fuel or fuel additives in the engine will render the three-way catalyst ineffective. Extremely high temperatures within the catalyst will impair or even melt the ceramic insert inside the converter.

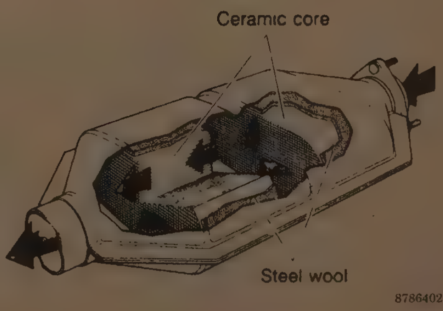


Fig. 28 Cutaway view of the three-way catalytic converter

Oxygen Sensor Feedback System

See Figures 29 and 30

This is a self-tuning engine control system (sometimes referred to as the Lambda Sond system), designed to reduce emissions and improve fuel economy. An exhaust gas sensor (oxygen sensor or lambda sensor) is located in the exhaust manifold and monitors the composition of the exhaust gasses leaving the engine. This analysis is fed into a closed loop feedback system. By reading the oxygen content of the exhaust stream, the system continuously adjusts the air/fuel mixture to provide optimum conditions for combustion and efficient breakdown of pollutants by the three-way catalytic converter.

The major components of the system are: the oxygen sensor, the electronic module and the frequency valve. The oxygen sensor is a platinum coated ceramic tube. It is located in the exhaust manifold. The inside is vented to the atmosphere while the outside is connected to the exhaust gas flow. The output from the sensor is fed to the electronic module. This device supplies a control current to the frequency valve.

The frequency valve alters the flow of fuel in the injection system by activating a diaphragm in the fuel pressure regulating valve. By altering the air/fuel flow in the system according to the signal received from the oxygen sensor, the frequency valve keeps the air/fuel mixture within the narrow band needed to allow the three-way converter to operate efficiently.

INSPECTION & REPLACEMENT

See Figure 31

The frequency valve (so called because it operates on a set frequency) functions during what is called its duty cycle. The duty cycle corresponds to the ratio of closed-to-open circuit impulses from the electronic module. The cycle can be measured in degrees by using a high quality dwell meter which reads up to 70° or more. The dwell meter is connected to an instrument pick-up connector located on a wire coming from the electronic module. The pick-up connector is located on the firewall, in the engine compartment to the left of the master cylinder. The dwell meter should be attached to the pick-up and ground.

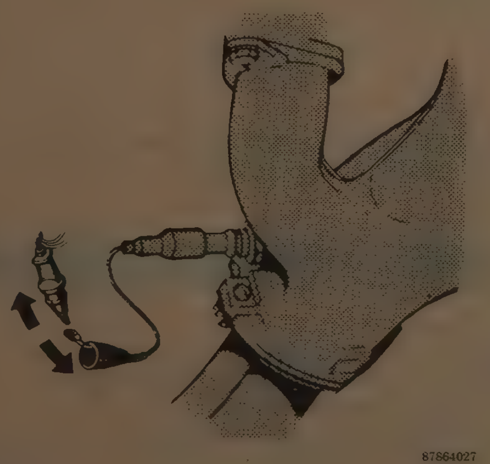


Fig. 29 Oxygen sensor location — B21 and B23 engines

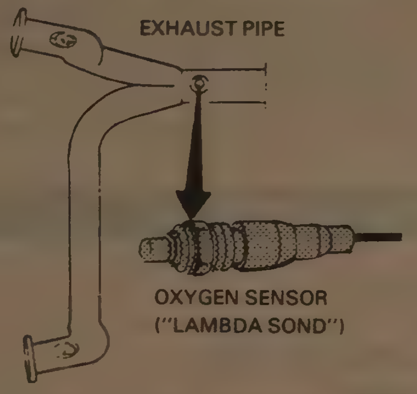


Fig. 30 Location of the B27F oxygen sensor. The sensor is mounted above the catalytic converter on B28F models

To check the oxygen sensor, connect the dwell meter to the pick-up and ground and run the engine to normal operating temperature. Start the engine and wait 10 seconds. If the oxygen sensor is defective (or cold), the duty cycle will be 54° for the B21F and 40-50° for the B27F and B28F.

The late model non-maintenance type sensors can only be checked by measuring emissions at the tailpipe with a CO (emissions testing) meter. If the oxygen sensor in the manifold is obviously damaged, it can be replaced by simply disconnecting it and unscrewing it from the manifold. When installing a new sensor, the threads must be coated with anti-seize compound. The unit should be tightened to 40 ft. lbs. (54 Nm). Use care in handling the oxygen sensor and its wire; it can be damaged by impact or dropping

On all gasoline powered U.S. and Canadian Volvos through the 1983 model year, the oxygen sensor must be replaced at 30,000 mile (48,309 km) intervals. For 1984, Canadian models with the B21A engine were exempt, but all U.S. models require a new sensor every 30,000 miles (48,309 km). In 1985,

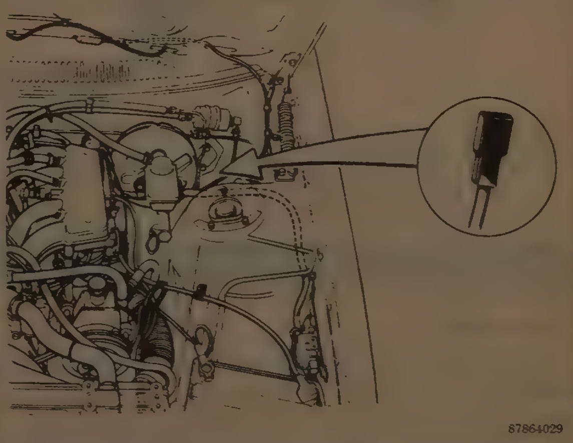


Fig. 31 Location of the pick-up connector for testing the duty cycle on the Lamda Sond system

the only models requiring replacement were the 760 GLE (B28F engine) and the 240 Turbo (B21F-Turbo engine). The 1986 760 GLE (B28F engine) was the last to require sensor replacement, again at 30,000 miles (48,309 km). All other 1986 and later models have sensors which are considered "life of the car" and do not require replacement unless they fail to function.

Emission Service Lights

RESETTING

See Figures 32, 33 and 34

After the required replacement service is performed on the oxygen sensor system, the service light in the dashboard may be reset. Remove the cover from the special odometer under the dashboard and depress the white button. This will reset the counter for the next 30,000 mile (48,309 km) segment. Not all models have oxygen sensor service lights.

Many Volvos, particularly the 700 series, have a service reminder light on the dashboard. When the elapsed mileage has reached 5000 miles (8052 km) since the last oil change, the light will come on for two minutes each time the engine is started. After changing the oil and filter and performing the other necessary safety checks, the reminder light may be reset by the following procedures.

On 740 and 780 models, the reset knob is found on the back of the instrument panel. Pressing the knob resets the counter for another 5000 mile (8052 km) increment. Use care in reaching behind the instrument cluster — don't pull any wires loose or disturb other components.

On the 760 model, remove the rubber grommet on the front of the instrument panel. This exposes the head of the reset button within the dash. Use a small screwdriver to depress the knob and reset the counter. Use care not to scratch the face of the dashboard when removing or installing the grommet.

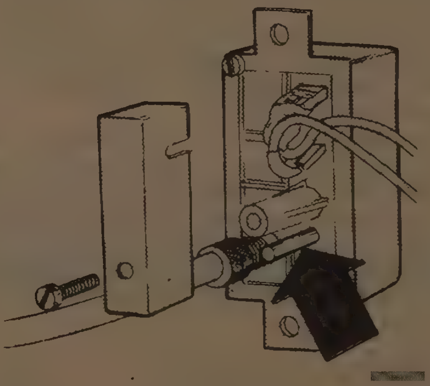


Fig. 32 To reset the EGR valve light, push the white button. The same counter is used for the catalytic converter and oxygen sensor lights

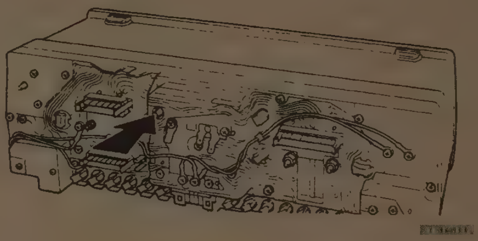


Fig. 33 Press the knob shown to reset the reminder light for 740 and 780 models

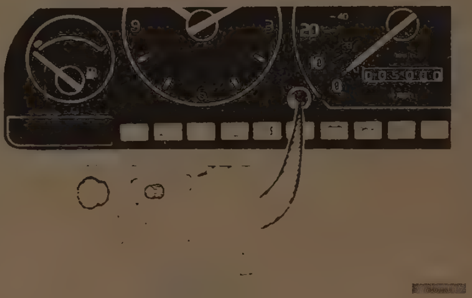


Fig. 34 Location of the service reminder light reset button for 760 series models

VACUUM DIAGRAMS

See Figure 35

Because Volvo was one of the first manufacturers to introduce reliable fuel injection on all their U.S. cars, the underhood area is mercifully free of complicated vacuum hose routing. Because vacuum circuits will vary based on various engine and vehicle options, always refer first to the vehicle emission control information label, if present. Should the label be missing, or should vehicle be equipped with a different engine from the vehicle's original equipment, refer to the diagrams below for the same or similar configuration.

If you wish to obtain a replacement emissions label, most manufacturers make the labels available for purchase. The labels can usually be ordered from a local dealer.

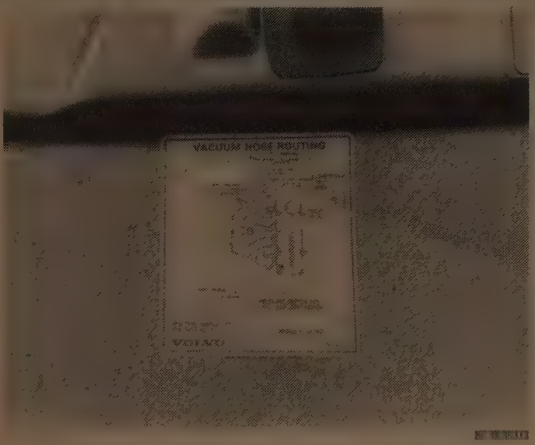

VACUUM HOSE ROUTING
VOLVO

Fig. 35 Always differ to the vacuum routing diagram located under the hood

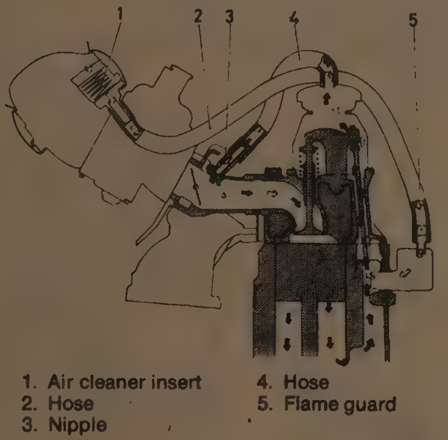

1
2
3
4
5
1. Air cleaner insert
2. Hose
3. Nipple
4. Hose
5. Flame guard

Fig. 36 Crankcase hose routing — B20B engine

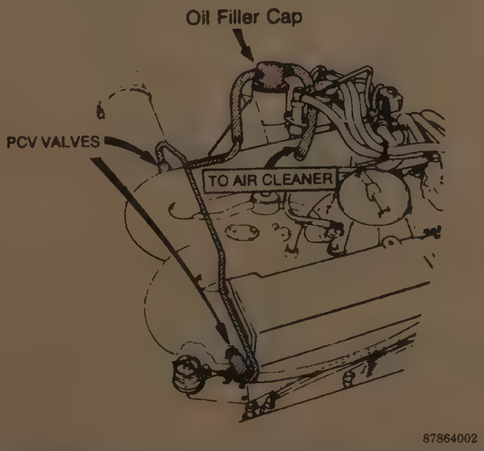

Oil Filler Cap
PCV VALVES
TO AIR CLEANER
87864002

Fig. 37 Crankcase valve and hose routing — dual PCV valve B27F engine shown, B28F engine similar

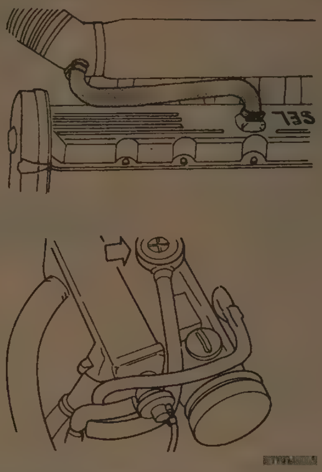
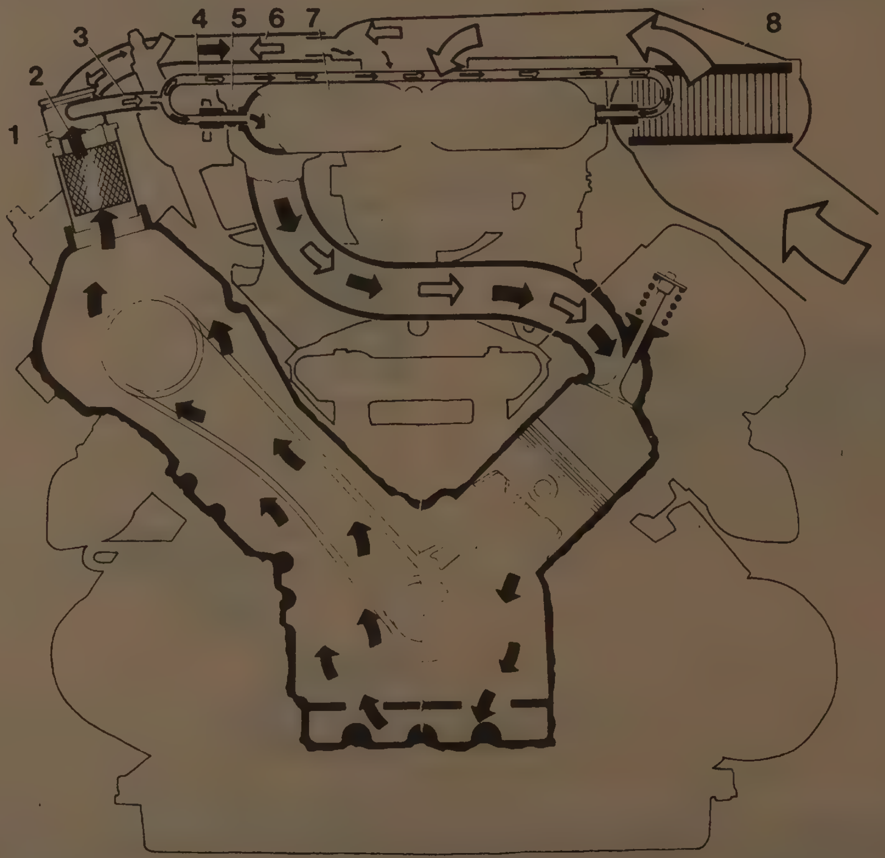


Fig. 38 Diesel crankcase hose routing — upper: D24 engine; lower: D24T engine



1. Oil trap
2. Flame guard
3. Hose, channeling crankcase fumes to the intake manifold
4. Distributor pipe
5. Nipple with orifice
6. Hose, channeling:
   —fresh air from the air cleaner to the crankcase (idle)
   —crankcase fumes to the air cleaner (cruising speeds)
7. Intake manifolc
8. Air cleaner.

87864009

Fig. 39 Crankcase ventilation system and hose routing — B27F, B28F and B280F engines

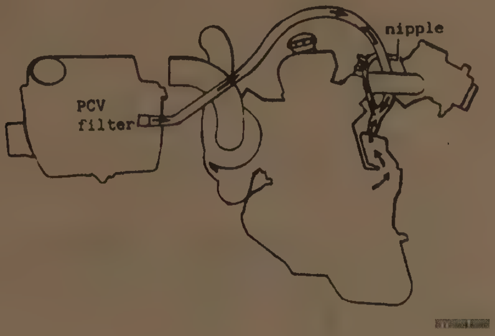
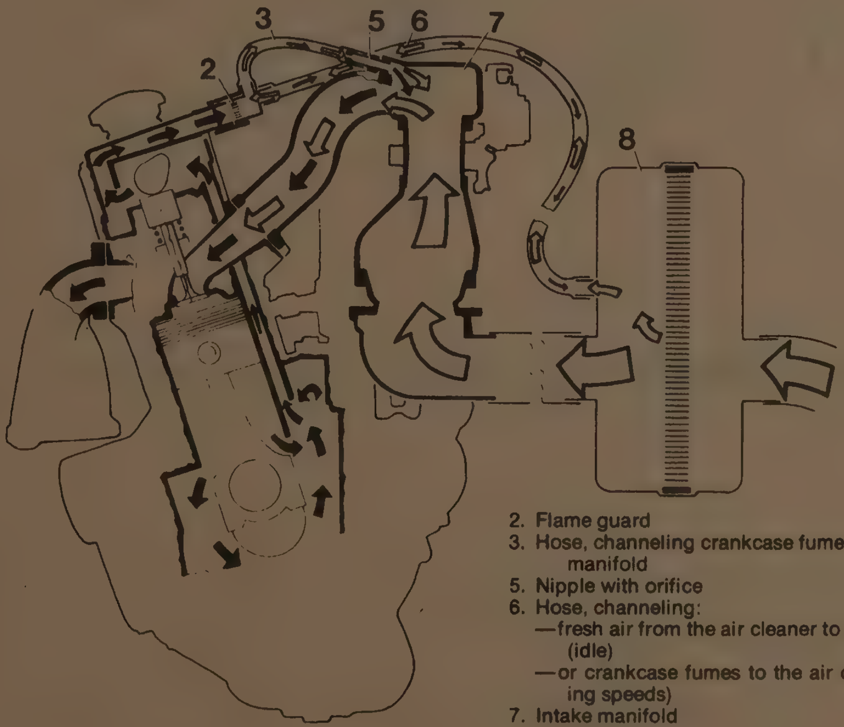
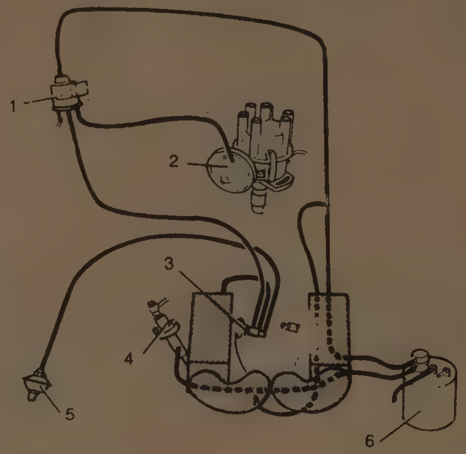


Fig. 40 Crankcase ventilation hose routing — B230F turbo engine



2. Flame guard
3. Hose, channeling crankcase fumes to the intake manifold
5. Nipple with orifice
6. Hose, channeling:
   - —fresh air from the air cleaner to the crankcase (idle)
   - —or crankcase fumes to the air cleaner (cruising speeds)
7. Intake manifold
8. Air cleaner

Fig. 41 Crankcase ventilation system and hose routing — B21, B23 and B230 engines



1. Ignition advance solenoid
2. Distributor
3. Thermal vacuum valve
4. Start injector pipe
5. Pressure differential switch
6. Charcoal canister and vacuum valve

87864033

Fig. 42 Vacuum hose routing — B28F and B280F engines

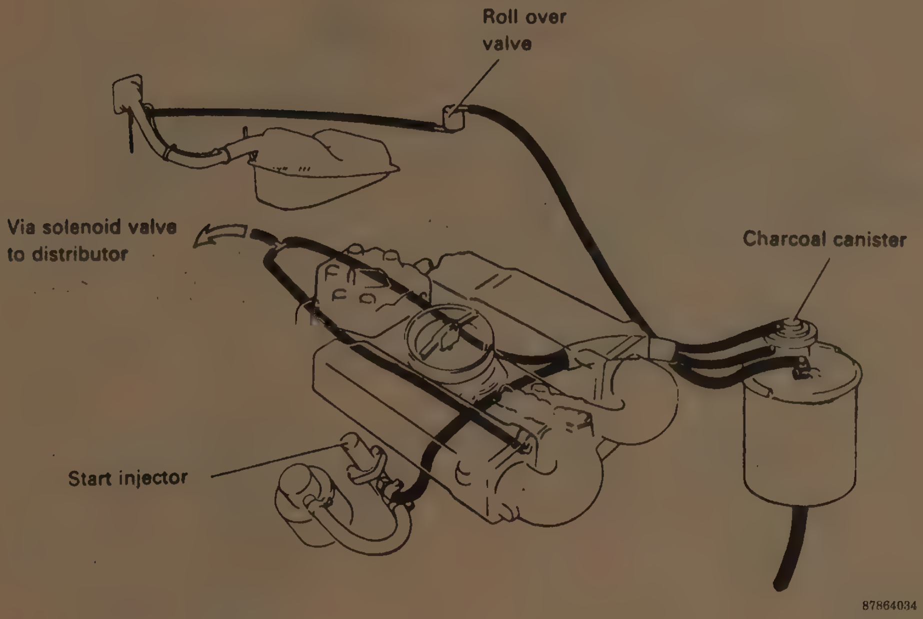
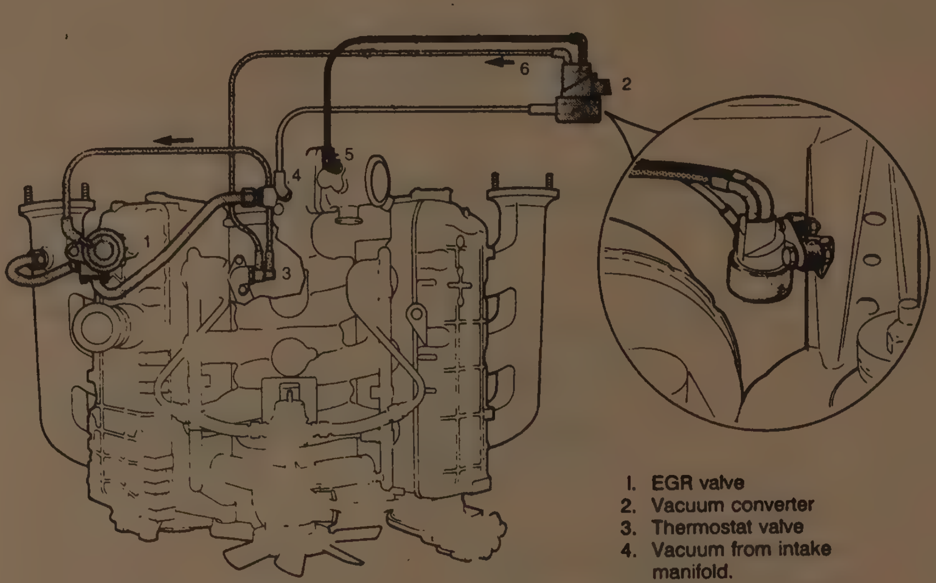

Roll over valve
Via solenoid valve to distributor
Charcoal canister
Start injector
87864034

Fig. 43 Hose routing for evaporative emissions control system — B28 and B280 engines



1. EGR valve
2. Vacuum converter
3. Thermostat valve
4. Vacuum from intake manifold.
5. Vacuum from throttle housing
6. Outbound vacuum from vacuum converter to thermostat valve and EGR valve

Fig. 44 EGR hose routing — B280F engines

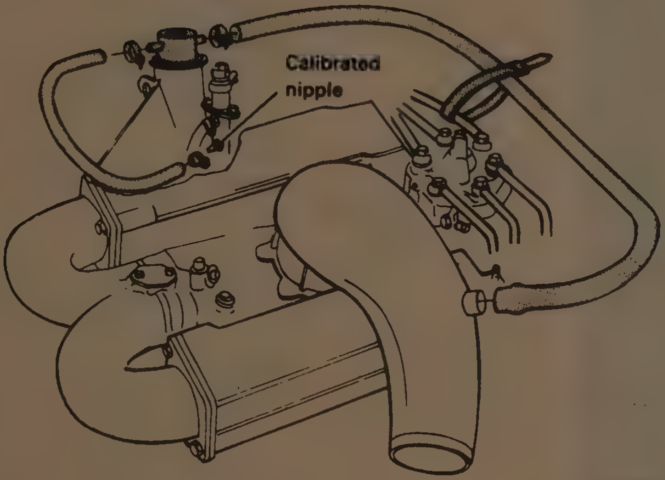

Calibrated
nipple

Fig. 45 Crankcase ventilation system — B28F and 280F engines

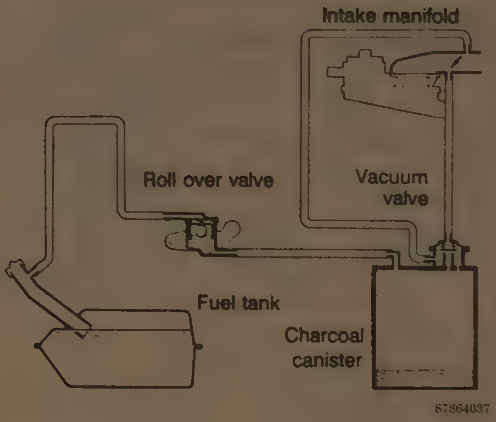

Intake manifold
Roll over valve
Vacuum valve
Fuel tank
Charcoal canister
87864037

Fig. 46 Schematic of evaporative emissions control system — DL and GL shown; other models use a similar system design

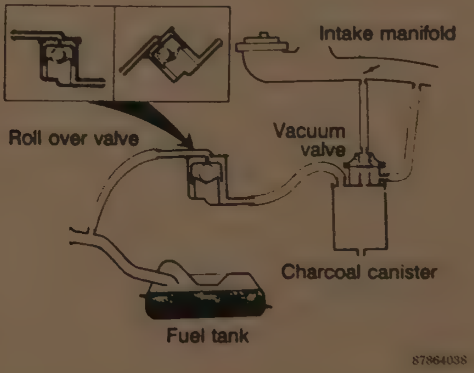

Intake manifold
Roll over valve
Vacuum valve
Charcoal canister
Fuel tank
87864038

Fig. 47 Schematic of evaporative emissions control system — 760 shown; other 700 series models are similar

5

FUEL SYSTEM

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CARBURETED FUEL SYSTEMS

Mechanical Fuel Pump

Carbureted engines are equipped with mechanical fuel pumps.

TESTING

No adjustments may be made to the fuel pump. Before removing and overhauling the old fuel pump, the following test may be made to determine if replacement is necessary.

****CAUTION**

To avoid accidental ignition of fuel during the test, first remove the coil high tension wire from the distributor and the coil. Disconnect the wire at BOTH ends to eliminate any chance of a stray spark being generated during cranking of the engine.

1. If a fuel pressure gauge is available, connect the gauge to the engine and crank the engine (with the key or a remote starter switch) until the pressure stops rising and record the highest pressure achieved. If the reading is within the specifications given in the Tune-Up Specifications chart in Section 2, the malfunction is not in the fuel pump. Check the pressure drop after the engine is stopped. A large pressure drop below the minimum specification indicates leaky valves. If the pump proves to be satisfactory, check the tank and inlet line.
2. If the fuel pressure gauge is not available, disconnect the fuel line at the pump outlet, place an approved gasoline container beneath the pump outlet, and crank the engine. A good pump will force the fuel out of the outlet in steady spurts. A worn diaphragm spring may not provide proper pumping action. Check the output through several strokes of the pump, looking for any sign of reduced flow or air bubbles.
3. As a further test, disconnect and plug the fuel line from the tank at the pump, and hold your thumb over the pump inlet. If the pump is functioning properly, a suction should be felt on your thumb when the engine is cranked. No suction indicates that the pump diaphragm is leaking or that the diaphragm linkage is worn.
4. Check the crankcase for gasoline. One quick check is to pull the dipstick and smell the oil; a better check is to examine a large sample (such a pan of recently drained oil) for odor and/or pollution. Gasoline will thin the oil in a fashion very similar to the effect of paint thinner in paint. A ruptured diaphragm can allow fuel to enter the oil system. This condition must be remedied as soon as possible. Damage to engine bearings can result if the oil is polluted with fuel.

REMOVAL & INSTALLATION

➧ See Figure 1

1. Label, disconnect and plug the inlet and outlet lines to the fuel pump.
2. Remove the two fuel pump retaining bolts, then carefully pull the pump and old gasket away from the block.
3. Discard the old gasket and position a new one on the pump to be reinstalled.

To install:

4. Mount the fuel pump and gasket to the engine block. Be careful to insert the pump lever (rocker arm) into the engine block and align it correctly above the camshaft.
5. While holding the pump securely against the block, install the two fuel pump retaining bolts, and tighten them securely.
6. Unplug and reconnect the fuel lines to the pump. Make sure the correct line is connected to each port.
7. Start the engine and check for fuel leaks. Also check for oil leaks where the pump attaches to the block. Depending on how much fuel was lost with the hoses disconnected, the engine may crank longer than normal before starting.

Carburetors

COMPONENT TESTING & ADJUSTMENT

Carbureted engines have incorporated many pollutant control devices, such as a temperature-regulated fuel jet, an air/fuel mixture preheating chamber, and a throttle bypass or over-rev valve. Measures have also been taken to improve the operation and driveability of emission controlled engines such as a cold start device, a constant intake air temperature device and a hot start valve. The temperature-regulated fuel mixture is accomplished differently on the Zenith-Stromberg carburetor than on the SU carburetor.

On the Zenith-Stromberg carburetor, a temperature sensitive bimetal spring (in the temperature compensator) actuates an air valve that varies the air supplied the venturi area, maintaining a constant air/fuel ratio. This ratio is maintained despite changing fuel temperature.

Within the SU carburetor, a temperature sensitive bimetal spring raises or lowers an adjustable jet to maintain the proper air/fuel ratio at changing fuel temperatures.

The air/fuel mixture preheating chamber used on pre-1972 models is located between the primary throttles in the carburetors and the secondary throttles in the intake manifold.

Temperature Compensator

ZENITH-STROMBERG CARBURETOR

➧ See Figures 2 and 3

➡Please refer to the component legend (following) for the Zenith-Stromberg carburetor. This procedure refers to components by number which makes the legend to which they are keyed necessary.

If the idle speed drops off sharply during extended periods of idling, especially during warm weather, the temperature

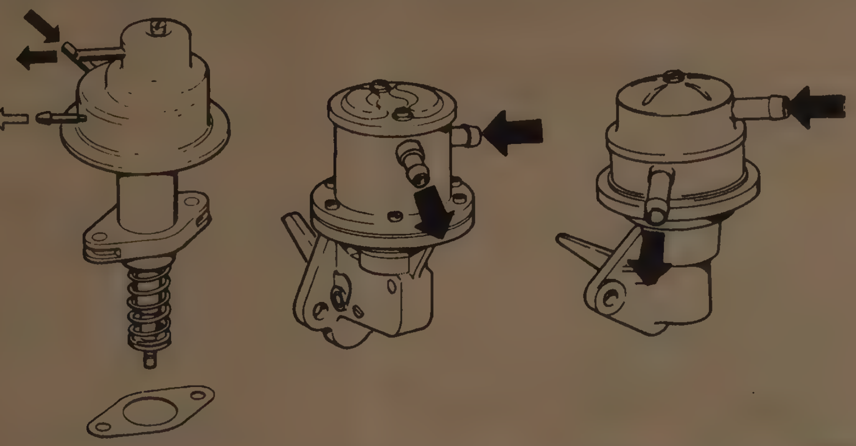
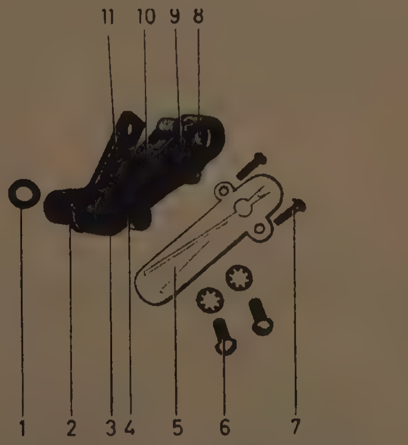


Fig. 1 Three types of mechanical fuel pumps used on carbureted Volvos — the arrows indicate flow direction

compensator may be in need of adjustment or replacement. Use the accompanying diagram to help you.

1. Remove the screws (7) holding the plastic cover (5) to the compensator and remove the cover.
2. With the ambient temperature at or above 85°F (29°C), the valve (3) should be able to be pressed inward with light finger pressure and then return to its position without jamming. If the valve jams and/or is stiff in operation, the temperature compensator should be replaced as a unit. See Temperature Compensator Replacement.
3. If properly adjusted, the valve will begin to open at 70-77°F (21-25°C), and will be fully open at 85°F (29°C). The valve may be adjusted while the temperature compensator is still on the carburetor by loosening one of the cross-slotted screws (8) for the bimetal spring (4), and centering the valve so that it opens and closes at the proper temperature. If necessary, the temperature compensator may be removed and isolated at 70-77°F (21-25°C) then adjusted with the nut (9) for the bimetal spring so that the valve is loose in its seat at this temperature.
4. Replace the cover and retaining screws on the compensator and check its operation during idling.



1. Rubber seal
2. Rubber seal
3. Valve
4. Bi-metal spring
5. Cover
6. Screws for temperature compensator
7. Screw for cover
8. Cross-slotted screw
9. Adjusting nut
10. Housing
11. Marking

Fig. 2 Component legend for the Zenith-Stromberg temperature compensator

Bypass Valve

ZENITH-STROMBERG CARBURETOR

If the engine does not return to idle speed soon after the throttle is released, and the throttle control linkage is properly adjusted, the bypass valve may be in need of adjustment or replacement.

1. If the engine refuses to lower its rpm to idle speed when the throttle is released, turn the bypass adjusting screw on the front carburetor to the left, and manually lower the idle.
2. Run the engine briefly up to approximately 2000 rpm, then release the throttle. If the engine returns to idle speed, turn the screw ½ turn further to the left. If the engine does NOT return to idle, replace the bypass valve as a unit.
3. Remove the air cleaner. While looking into the carburetor bores, observe the air valves. Briefly race the engine and then release the throttle. The air valve of the front carburetor should normally go down to the bridge slower than the air valve of the rear carburetor. Turn the bypass adjusting screw to the

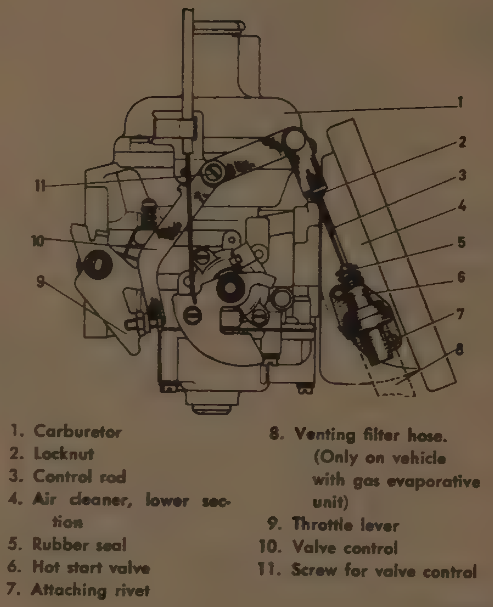


Fig. 3 Component legend for the Zenith-Stromberg carburetor

right until the normal function is obtained. If the valve cannot be adjusted so that the front air valve goes down to the bridge slower than the rear air valve, the bypass valve must be replaced as a unit. See Bypass Valve Replacement.

Hot Start Valve

ZENITH STROMBERG CARBURETOR

With the throttle at idle, adjust the valve control of the hot start valve so that the valve is against the carburetor lever with the valve piston in the upper position. Coat the contact surfaces on the valve and carburetor with high temperature white grease such as Molykote®. Test the operation of the hot start valve by confirming that the engine returns to idle after several brief periods of racing the engine.

SU CARBURETOR

➧ See Figure 4

To adjust the hot start valve, press the control rods down to the bottom position and measure the distance (A) between the rod and the adjusting screw. Adjust the distance to a maximum of 0.04 in. (1mm).

Test the operation of the control rods. Make sure that they do not jam.

Constant (Intake) Air Temperature Device

➧ See Figure 5

If the flap for the constant air temperature device sticks in one position, engine operation will suffer. Normally, the flap is closed to cold air (intake hose) at an ambient temperature of 70-77°F (21-25°C) and closed to hot air (ducted from the exhaust manifold) at 95°-105°F (35-40°C). Depending on the temperature, the flap can remain in a partially open position, blending the warm and cool air to achieve the proper intake air temperature.

1. The operation of the flap may be checked with the housing installed on the car. When the small tab on the flap housing points toward the mark closest to the exhaust heat hose, the flap is open for hot (preheated) air. When the tab points to the mark nearest the cold air intake, the flap is open for cold (outside) air. If the tab indicates that the flap is opening and closing the air sources at the right temperatures, it is operating correctly. If not, check the operation of the flap control thermostat.
2. Disconnect the flap housing from the air intake hoses. Immerse the thermostat in lukewarm water. At a water temperature of 70-77°F (21-25°C), the thermostat should be in its upper (toward the flap housing) position. At 95-105°F (35-40°C), the thermostat should be in its lower position (away from the flap housing). If correct operation cannot be obtained, replace the thermostat and flap housing as a unit.
3. Replace the flap housing and thermostat assembly, making sure that the thermostat is centered in the middle of the air flow. Secure the hose clamp screw on top of the flap.

Float Adjustment

ZENITH-STROMBERG CARBURETOR

➧ See Figure 6

1. Remove the carburetor.
2. Invert the carburetor and remove the float chamber.

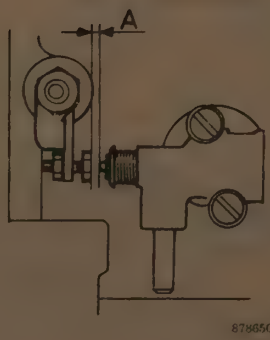
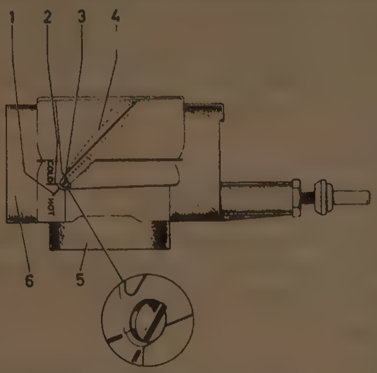


Fig. 4 Hot start valve clearance — SU carburetor



1. HOT = open for warm air
2. COLD = open for cold air
3. Tab
4. Flap
5. Hot air intake
6. Cold air intake

Fig. 5 Details of the air temperature flap

3. While referring to the Zenith-Stromberg float adjustment drawing, adjust the float so that the high point (distance B) of the float is ⅝ in. (16mm), and the low point (distance A) of the float is ½ in. (13mm), from the sealing surface of the carburetor housing.

4. To adjust the float level, bend the tab at the float chamber inlet valve. Do not bend the arm between the float and the pin.

5. When the proper adjustment has been made, install the float chamber to the housing with a new gasket.

6. Reinstall the carburetor on the intake manifold.

SU CARBURETOR

➧ See Figure 7

1. Remove the carburetor.
2. Invert the carburetor and remove the float chamber.
3. The float is correctly adjusted when the distance A between the float valley and the housing flange is approximately 0.02-0.06 in. (0.50-1.50mm).
4. The float is adjusted by bending the metal tab at the float chamber inlet valve.

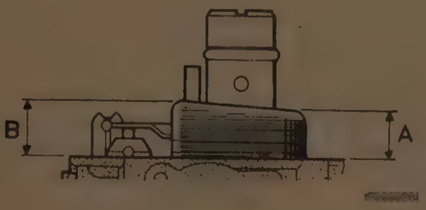


Fig. 6 Adjust the float level by precisely measuring the high and low points — Zenith-Stromberg carburetor

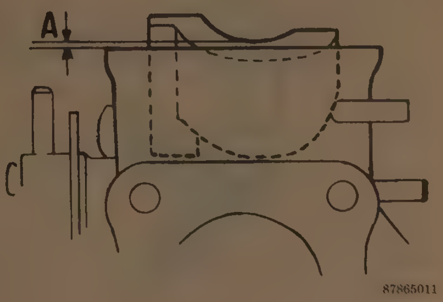


Fig. 7 Bend the metal tab to adjust the float level

5. When the correct adjustment has been made, install the float chamber to the housing with a new gasket.
6. Install the carburetor.

Fast Idle Adjustment

ZENITH-STROMBERG CARBURETOR

Pull out the choke control one inch from the dash. If the choke is adjusted correctly, the mark on the fast idle cam (see illustration) should be opposite the centerline of the fast idle screw. Adjust the fast idle with the fast idle screw to 1100-1300 rpm. For cars with dual carburetors, make sure you set the fast idle on both carburetors.

SU CARBURETOR

Pull out the choke control 0.8 in. (20mm) from the dash. Adjust the fast idle (with the fast idle screw) to 1100-1600 rpm. Remember to set both carburetors if so equipped.

Throttle Linkage Adjustment

➧ See Figures 8 and 9

On each carburetor, the link rods should maintain a 0.004 in. (0.1mm) — clearance A — between the lever and the throttle spindle flange when the throttle control is against the intake manifold bracket. To adjust this clearance, remove the ball-and-socket link from the carburetor stud, and turn the socket on the threaded rod until the adjustment is correct. Remember that you are seeking a clearance measured in thousandths of an inch; the link should not require a great amount of turning.

COMPONENT REMOVAL & INSTALLATION

Temperature Compensator

ZENITH-STROMBERG CARBURETOR

➡Please refer to the component legend for the Zenith-Stromberg carburetor. This procedure refers to components by number which makes the legend to which they are keyed necessary.

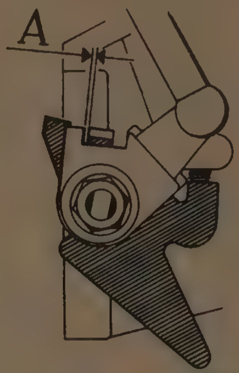


Fig. 8 Carefully turn the socket on the threaded rod to adjust the linkage to the proper clearance — Stromberg carburetor

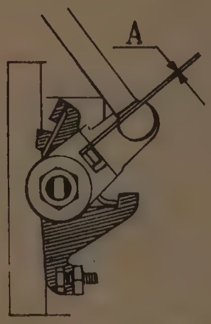


Fig. 9 Only minute adjustments should be necessary for adjusting the carburetor linkage — SU carburetor

1. Remove the retaining screw (6) and lift off the compensator.
2. Discard the old rubber seals (1, 2) and replace them with new ones.
3. Position the compensator to the side of the carburetor and install the retaining screws.
4. Check the operation of the compensator during idle.

Bypass Valve

ZENITH-STROMBERG CARBURETOR

➧ See Figure 10

1. Remove the three retaining screws (6) and lift off the bypass valve.
2. Discard the old bypass valve-to-carburetor housing gasket.
3. Position a new gasket and bypass valve to the carburetor, making sure that the orifices and mating surfaces of the valve and gasket align and install the three retaining screws.
4. Check the operation of the bypass valve. (See Bypass Valve Testing and Adjustment.)

Hot Start Valve

ZENITH STROMBERG CARBURETOR

The hot start valve on the Zenith-Stromberg carburetor is riveted to the air cleaner. If the valve requires cleaning, it must be done with the assembly in place on the engine.

SU CARBURETOR

1. Remove the two retaining screws and lift off the valve.
2. Discard the old gasket and clean the channels in the carburetor with a low pressure air line.
3. Position the valve and new gasket to the carburetor, making sure that the gasket is aligned properly, then install the two retaining screws.
4. Adjust the position of the control rod and test the operation of the valve. (See Hot Start Valve Testing and Adjustment.)

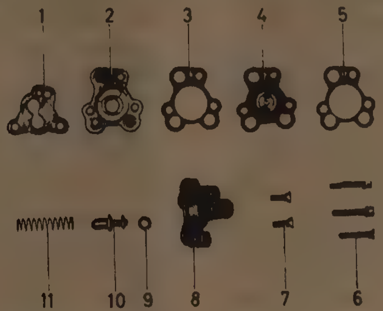
Constant Air Temperature Device Flap Housing

1. Loosen the hose clamps and disconnect the flap housing and thermostat assembly from the hoses for the intake air, heated air, and intake manifold.
2. Install the new flap housing assembly in position and reconnect the three hoses. Make sure that the thermostat is centered in the middle of the intake air flow. Secure the hose clamp screw on top of the flap.
3. Check the operation of the new flap housing. (See Constant Air Temperature Device Testing and Adjustment.)

Cold Start Device Seals

SU CARBURETOR

1. Pry off the lockwasher for the cold start device and unscrew the channel disc nut.
2. Disconnect the return spring and remove the channel disc and spring.
3. Remove the two retaining screws and the spring retainer.
4. Lift the cold start device away from the carburetor. Press the spindle out of the cold start device housing. Remove the gasket the rubber ring, and rubber seal from the spindle, and discard them. Clean all metal parts with kerosene (not gasoline) and clean the fuel channels with an compressed air.
5. Install a new rubber ring and seal on the housing and oil them with light engine oil (use 10W, or if this is not available, 10W-30 will suffice). Install the spindle into the housing.
6. Position the housing assembly, with a new gasket, on the carburetor. Fit the spring retainer and install the retaining screws.
7. Position the return spring in its retainer so that the spring's short end fits into the retainer slot.
8. Hook the channel disc onto the spring's longer end and install the disc on the spindle. Install the channel disc retaining nut and snap on the lockwasher.



1. Gasket
2. Housing
3. Gasket
4. Diaphragm
5. Gasket
6. Screw for by-pass valve
7. Screw for cover
8. Cover
9. Rubber ring
10. Adjusting screw
11. Spring

Fig. 10 Components comprising the bypass valve

Damping Piston Replacement

➧ See Figure 11

If the engine stumbles upon acceleration, and the damping cylinders are filled to their proper level with oil, the problem may be with the damping pistons themselves. Unscrew the black knobs on top of the carburetors and remove the damping pistons. If the axial clearance **A** between the bottom of the piston and the retaining clip is not 0.04-0.08 in. (1.0-2.0mm), the piston must be replaced as a unit.

Carburetor Diaphragm Replacement

ZENITH-STROMBERG CARBURETOR ONLY

The Stromberg carburetor differs from the SU carburetor in that it has a rubber diaphragm attached to the air valve. Vacuum from the intake manifold acts upon the diaphragm to raise and lower the air valve. Obviously, if the diaphragm rips (which can happen due to age and/or chemical deterioration), engine performance will suffer measurably. This procedure is done with the carburetor on the engine.

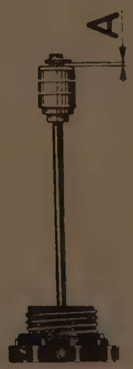


Fig. 11 Damping piston axial clearance is measured between the retaining clip and the bottom of the piston

1. Remove the damper piston from the top of the carburetor.
2. Remove the four screws and remove the top of the carburetor.
3. Remove the large spring and remove the air valve complete with rubber diaphragm.
4. Check the diaphragm for rips and brittleness. If no rips or deterioration are evident, reuse the diaphragm.
5. If the diaphragm is ripped or damaged, remove the four screws and remove the diaphragm washer and the diaphragm.

To install:

6. Fit a new diaphragm. The diaphragm will fit on the air valve only one way: it has a notch in it which must be inserted in the notch on the air valve.
7. Fit the air valve and diaphragm on the carburetor. You may have to remove the air cleaner to guide the needle on the air valve into its jet. Place the air valve into the carburetor so that the notch in the outside of the diaphragm fits into the notch in the carburetor body.
8. Reinstall the spring and carburetor top. Fill the damper with ATF fluid and install the damper piston.

REMOVAL & INSTALLATION

Two different types of carburetors were used on 1970-72 Volvos. A pair of sidedraft Zenith-Stromberg 175 CD2 SE units were used on 1970 140 series models, and on 1970-72 164 models. A pair of sidedraft SU HIF units were used on 1971-72 140 series models.

➡All wires and hoses should be labeled at the time of removal. The amount of time saved during reassembly makes the extra effort well worthwhile.

1. On the Zenith-Stromberg carburetor, disconnect the hot start valve control. Separate the air cleaner halves and remove the inner half from the carburetors.

2. Disconnect the throttle linkage by removing the link rod ball joints from the carburetors. Disconnect the choke cable, taking note of its proper routing and adjustment.

3. Disconnect and plug the fuel lines at the float chambers. Remove the vacuum hose for the distributor. On the SU carburetor, disconnect the hot start valve hose.

4. Remove the four nuts retaining the carburetor to the intake manifold. Remove the carburetors, gaskets, and protection plate. Keep the carburetor vertical and remove it from the engine are. Safely drain the remaining fuel within the bowls of the carburetor and cap the container. When repairing the carburetor on the workbench, keep the area clean and free from dirt and dust.

To install:

5. Position the protection plate, new gaskets, and carburetor on the intake manifold studs. Install the carburetor retaining nuts and tighten them evenly until they are snug against the manifold.

6. Connect the vacuum hoses, fuel hoses, choke, and throttle linkage. On the SU carburetor, connect the hot start valve hose.

7. Install the inner half of the air cleaner to the carburetors. Adjust the idle speed and mixture of the carburetors. (see Section 2.)

8. Fit the air cleaner halves together and, on the Stromberg carburetor, connect the hot start valve control.

CARBURETOR OVERHAUL

➧ See Figures 12 and 13

Carburetors are relatively complex. Proper performance depends upon the cleanliness and proper adjustment of all internal and external components. In addition to the usual adjustments performed at the regular tune-up intervals, it eventually becomes necessary to remove, disassemble, clean, and overhaul the entire carburetor in order to restore its original performance.

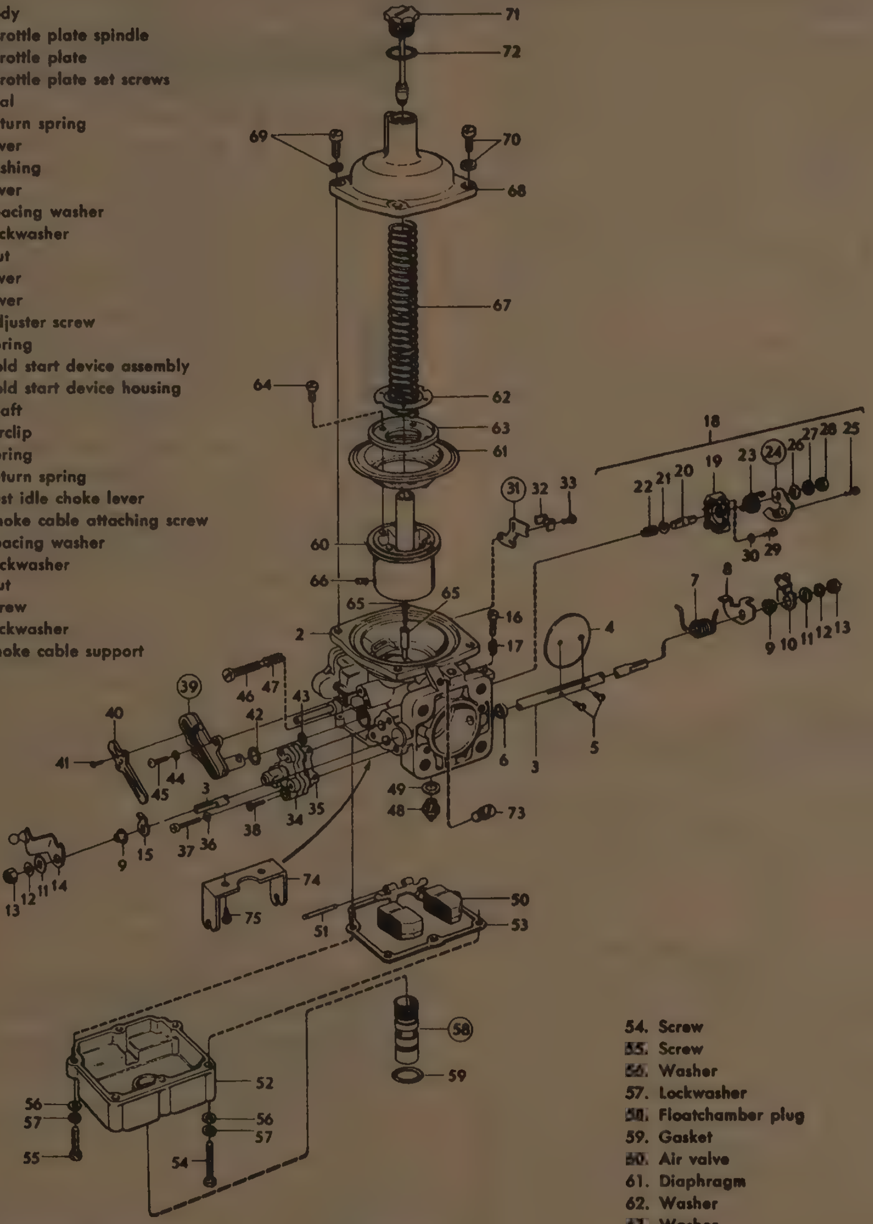
To overhaul a carburetor, first purchase the proper rebuilding kit. Read the instructions and study the exploded view of the carburetor thoroughly prior to the actual removal and disassembly.

After reading the detailed carburetor rebuilding instructions, the following general procedure may be used. Remove the carburetor and place it on a clean work table. Disassemble the carburetor by removing the screws securing the upper and lower sections together. Remove the damping piston, air valve, spring, metering needle, fuel jet (SU only), and float assembly.

Soak all metal parts in carburetor cleaning solvent. Scrape all old gasket material from the mating surfaces. After the metal parts have been soaked to remove all gum, varnish, and dirt, rinse them off with a clean, uncontaminated, solvent solution. Blow out all passages with compressed air and allow them to air dry. Do not use drills or wire to clean the passages.

Check the throttle shaft and choke disc for excessive wear. Inspect the float hinge pins for distortion. All non-metal parts that are not being replaced should be wiped clean with a lint-free cloth. After all of the parts have been sufficiently cleaned or replaced, assemble the carburetor using new gaskets and seals, and, on Zenith-Stromberg carburetors, a new air valve diaphragm. If any of the replacement seals in an SU carburetor are cork, they must first be soaked in penetrating oil for a minimum of a half hour to avoid splitting during installation.

Assemble the float chamber and adjust the float height. Assemble the air valve, spring, and metering needle into the upper housing. Join the upper and lower housing together, taking care to properly align the metering needle and fuel jet. When the jet and needle are installed correctly, the air valve should drop to the bridge with a distinctive click. Any binding of these two parts will result in poor carburetor performance. Install the damping piston. Install the carburetor on its manifold with a new gasket. Adjust the choke and throttle linkage, and the idle speed. Run the engine through a full cold start, warm up and hot restart cycle to check for proper function of all carburetor systems. Make adjustments as necessary.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2. Body
3. Throttle plate spindle
4. Throttle plate
5. Throttle plate set screws
6. Seal
7. Return spring
8. Lever
9. Bushing
10. Lever
11. Spacing washer
12. Lockwasher
13. Nut
14. Lever
15. Lever
16. Adjuster screw
17. Spring
18. Cold start device assembly
19. Cold start device housing
20. Shaft
21. Circlip
22. Spring
23. Return spring
24. Fast idle choke lever
25. Choke cable attaching screw
26. Spacing washer
27. Lockwasher
28. Nut
29. Screw
30. Lockwasher
31. Choke cable support
32. Choke cable retaining clip
33. Screw
34. By-pass valve assembly (front carb only)
35. Gasket
36. Lockwasher
37. Screw
38. Screw
39. Temperature compensator housing
40. Temperature compensator cover
41. Screw
42. Rubber seal
43. Rubber seal
44. Lockwasher
45. Screw
46. Idle trimming screw
47. Spring
48. Needle valve with seat
49. Gasket
50. Float
51. Float hinge pin
52. Floatchamber cover
53. Gasket
54. Screw
55. Screw
56. Washer
57. Lockwasher
58. Floatchamber plug
59. Gasket
60. Air valve
61. Diaphragm
62. Washer
63. Washer
64. Screw
65. Metering needle
66. Metering needle retaining set screw
67. Air valve return spring
68. Suction chamber cover
69. Screw and washer
70. Screw and washer
71. Damping piston assembly
72. Damping piston gasket
73. Plug for air conditioner speed compensator

Fig. 12 Exploded view of the Zenith-Stromberg carburetor

2. Housing
2A. Plug
3. Key
4. Screw
5. Pin
6. Spring
7. Circlip
8. Bearing
9. Gasket
10. Screw
11. Jet
12. Bimetal assembly
13. Spring
14. Screw
15. O-ring
16. Adjuster screw
17. Seat
18. Needle valve
18A. Needle valve with seat
19. Float
20. Washer
21. Spindle
22. Floatchamber cover
23. Rubber ring
24. Lockwasher
25. Screw
26. Throttle plate spindle
27. Throttle plate
28. Throttle plate set screw
29. Sealing ring
30. Lever
31. Adjuster screw
31A. Spring
32. Spacing sleeve
33. Spring
34. Lever
35. Lever
36. Bushing
37. Lockwasher
38. Nut
39. Spacing washer
40. Lever
41. Adjuster screw
42. Locknut
43. Lockwasher
44. Nut
45. Valve spindle
46. Washer
47. Circlip
48. Valve sleeve
49. O-ring
50. Gasket
51. Sealing ring
52. Retainer
53. Screw
54. Return spring
55. Lever
55A. Screw
56. Lockwasher
57. Nut
58. Hot start valve assembly
59. Gasket
60. Lockwasher
61. Screw
62. Suction chamber
63. Suction piston (air valve)
64. Metering needle retaining set screw
65. Suction piston return spring
66. Jet needle
67. Spring
68. Jet needle guide
69. Damping piston assembly
70. Damping piston gasket
71. Screw

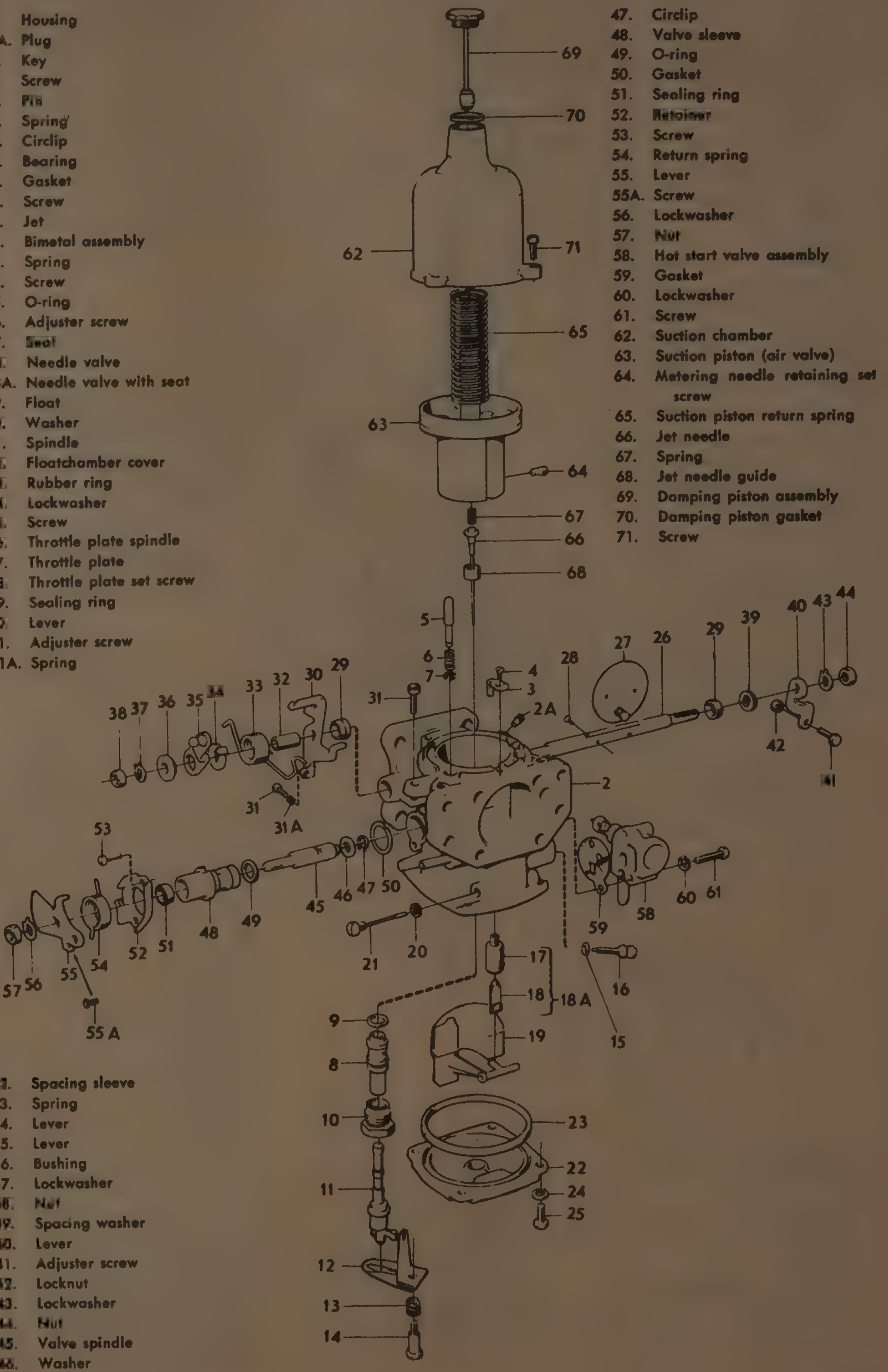
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Fig. 13 Exploded view of the SU carburetor

GASOLINE FUEL INJECTION SYSTEMS

General Information

Fuel injection combined with electronics and various engine sensors provides a precise fuel management system that meets all the demands for improved fuel economy, increased performance and lower tailpipe emissions. A fuel injected engine generally averages ten percent more power and fuel economy (with lower emissions) than a carbureted engine.

Because of its precise control, fuel injection allows the engine to operate at the optimum (stoichiometric) fuel ratio of 14.7:1 (14.7 parts air to 1 part fuel) throughout the entire range of engine operation — from idle through wide-open throttle. By using an oxygen sensor to measure the content of the exhaust gasses, the Electronic Control Unit (ECU), an onboard computer, can adjust the fuel mixture in response to the changing temperature, load and altitude conditions.

It is important to identify all system components, how they work and their relationship to one another before attempting any maintenance or repair on the system. All fuel injection systems are delicate and vulnerable to damage from dust, dirt, water and careless handling. The shock of hitting a cement floor when dropped from waist height can ruin a computer unit. Because of the close tolerances involved within a fuel injector, any particle of rust or dirt in the fuel lines can cause more damage than a well placed grenade.

Many components, while similar in appearance, can vary in their function or electrical properties. Each individual system has some sensors, capabilities and characteristics unique to its own design. Further, injection systems receive constant modifications and improvements during the production run. For these reasons, the careful recording of part numbers and/or engine numbers is essential to obtaining the correct replacement parts.

Safety Precautions

**CAUTION

Whenever working on or around any fuel injection system, always observe these general precautions to prevent the possibility of personal injury and/or damage to the fuel system components.

- The fuel system is under pressure. Release pressure slowly and contain spillage. Observe no smoking/no open flame precautions.
- Never install or remove battery cables with the key **ON** or the engine running. Jumper cables should be connected with the key **OFF** to avoid power surges that can damage electronic control units. Engines equipped with fuel injection units should (where possible) avoid giving or receiving jump starts to avoid the risk of serious damage by electrical arcing.
- Always remove the battery cables before charging the battery. Never use a high output charger on an installed battery. Never use any type of "hot-shot" (24 volt) starting aid.
- Never attach or remove wiring harness connectors with the ignition switch **OFF**, especially to the electronic control unit.
- Always depressurize the fuel system before disconnecting any fuel lines.
- Always use clean rags and tools when working on an open fuel injection system and take extreme care to prevent any dirt from entering the system.
- Wipe all components clean before installation and prepare a clean work area for any disassembly or inspection. Avoid the use of caustic cleaning solvents.
- Avoid any rough handling of components. If a component is dropped or subjected to impact, consider it failed until thoroughly checked for all functions.
- Remove the electronic control unit if the vehicle is to be in an environment with temperatures over 170°F (77°C), such as a paint spray booth. Remove the ECU if any welding is to be done on the car.

Electric Fuel Pump

All fuel injected models use similar fuel pumps, although the pumping capacity will vary depending on the type of fuel injection and size of the engine. Beginning in the middle of the 1976 production year, a second fuel feed fuel pump was fitted inside the fuel tank and is integral with the fuel tank sender unit.

The purpose of the fuel feed pump is to supply fuel under lower pressure to the main fuel pump. This arrangement reduces the possibility of vapor lock and relieves some of the strain on the external pump. This in-tank pump can be fitted on earlier model continuous (mechanical) fuel injected vehicles.

Because of the need for constant fuel pressure in the continuous fuel injection system, a fuel accumulator is installed between the fuel pump and the engine. The accumulator smooths out fuel pump pulsing and maintains fuel pressure in the line after the engine is stopped to insure quick start-ups.

On both continuous and electronic fuel injected models, the fuel pump is a wet type, roller fuel pump. As the pump motor spins, the rollers are forced outwards by centrifugal force and ride against the eccentrically shaped pump chambers. Fuel is drawn into the cavities between the rollers and forced outward to the line under pressure.

➡Volvo states that a no-start condition may occasionally occur when the engine has not been started for an extended period of time. This may be due to the fuel pump sticking in one position because of foreign matter, or corrosion forming on the rotor shaft or commutator and brushes. It is very important to clean the fuel tank pick-up screen or filter at the recommended intervals to prevent water condensation and foreign matter from entering the pump. As an additional corrosion prevention measure, add an alcohol solution or gas line antifreeze to the fuel, especially in winter months or if storing the car for a period of weeks or months. When the pump does become stuck in one position for any of the above reasons, first try the simplest method to free it. With the ignition switched ON try to free the pump by lightly tapping on its casing with a length of hardwood such as a hammer handle. This simply loosens the binding material within the pump and allows the motor to turn the pumping mechanism. It is one of the few occasions when a bit of controlled violence will cure an electrical problem.

TESTING & ADJUSTMENT

No adjustment may be made to the fuel pump. If the pump is not functioning properly, it must be discarded and replaced. To check the function of the fuel pump, the pump should be connected to a pressure gauge. Be careful not to switch the electrical leads. If the pump fails to develop its proper pressure, or if it cannot pump deliver that pressure at its specified amperage, it must be replaced. It is recommended that you consult your dealer or other reputable repair facility for accurate testing of the fuel pump pressure and amperage.

REMOVAL & INSTALLATION

◆ See Figures 14, 15, 16, 17 and 18

The fuel pump is located either in front of or beside the fuel tank. On continuous fuel injection models, it is located with the fuel accumulator.

✲✲CAUTION

The fuel system is under pressure. Release pressure slowly and contain spillage. Observe no smoking/no open flame precautions

1. Remove the gas cap. Remove the electrical lead from the pump as well as the plate to which the pump is mounted if necessary.
2. Clean around the hose connections. After labeling the fuel lines, pinch them shut, loosen the hose clamps and disconnect the lines. Take care not to crush or damage the hoses when pinching them.
3. Loosen the retaining nuts and remove the pump from its rubber mounts.

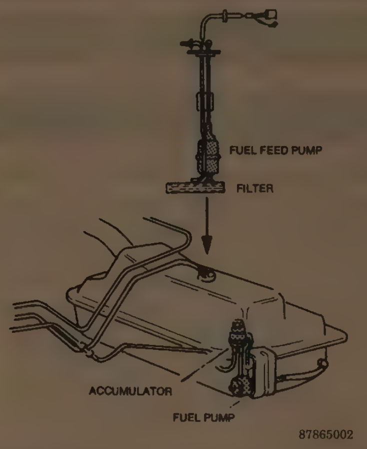

Fig. 14 Exploded view of the fuel feed pump used on some 1976, all 1977 and later U.S. model Volvos

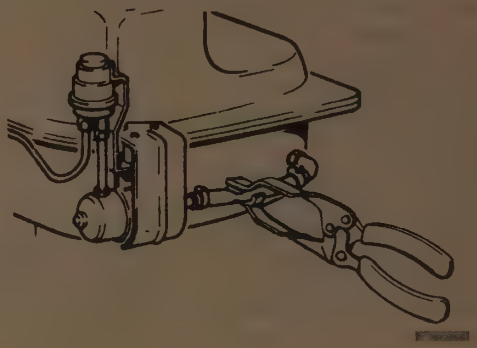

Fig. 15 Pinch shut the fuel line when removing the fuel pump

Fig. 16 Remove the bolts securing the mounting plate, then lower it with the fuel pump

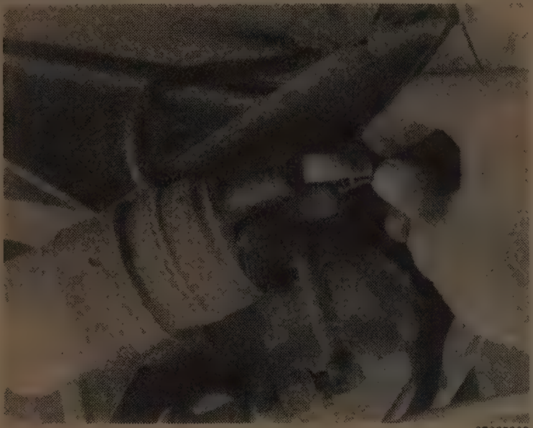
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Fig. 17 Unplug the fuel pump electrical connector — this may be done before or after lowering the pump

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Fig. 18 This special clamp (with no sharp edges) is the best tool to close-off fuel lines

To install:

4. Install the new pump on its rubber mounts and tighten the retaining nuts.
5. Reconnect the fuel lines, tighten the hose clamps, and remove the pinchers.
6. Mount the plate beneath the car and connect the electrical lead.
7. Start the engine and check for leaks.

Bosch Electronic Fuel Injection

1975 AND EARLIER MODELS

➧ See Figures 19 and 20

All 1973 and earlier fuel injected models and the 1974-75 164 use the Bosch electronic fuel injection system. Fuel is drawn from the fuel tank by the electric fuel pump and forced through the fuel lines and filter to the pressure regulator. The pressure regulator supplies fuel at a constant pressure of 28 psi (193 kPa) to the injectors. The electromagnetic fuel injectors are mounted in the intake ports of the cylinder head.

The duration of fuel injection, and, consequently, fuel quantity, is controlled by engine rpm and load. Engine rpm information is supplied to the electronic brain via the distributor triggering contacts. Engine load information is supplied by the intake air pressure sensor. The electronic brain uses this information to determine the length of time the injectors will remain open. During warm-up periods, the cold start valve injects extra fuel into the intake air stream when the starter is operated. At the same time, the auxiliary air regulator supplies extra air until the engine reaches operating temperature.

When the engine is accelerated, the throttle valve switch sends electrical impulses to the brain to increase the time the injectors are open. When decelerating, the throttle valve switch sends another impulse to the brain, closing off the fuel flow. When engine speed drops to approximately 1,000 rpm, the fuel supply is turned on again, allowing a smooth transition to idle speed.

COMPONENT TESTING, ADJUSTMENT & REPLACEMENT

Through 1975, B20 and B30 engines

The fuel injection system is repaired simply by replacing the defective component. There are adjustments that can be made to the pressure regulator, throttle valve, throttle valve switch, throttle stop-screw, and the fuel mixture. To make resistance checks, use an ohmmeter and for continuity checks, a 12V test light. If the control unit is defective, return it to a qualified repair agency and install a new unit.

CONTROL UNIT

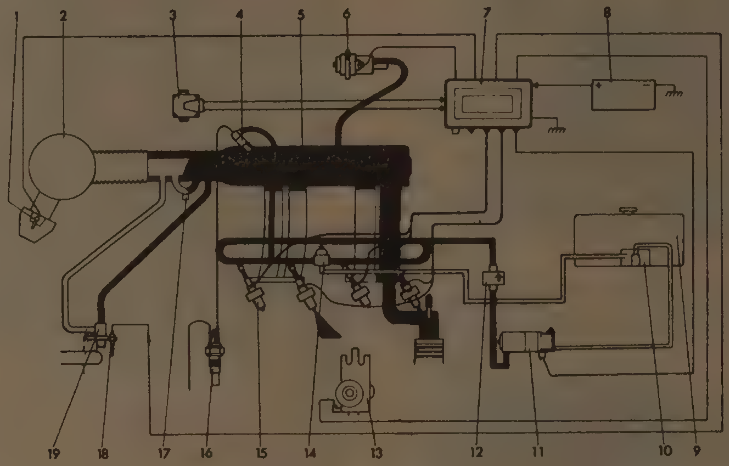
➧ See Figure 21

The idle mixture may be adjusted with the slotted knob on the control unit. This operation is best performed with the use of a CO meter, which is available on the dealer level. The control unit may be tested only with the help of sophisticated test equipment available, again, only at the dealer level. To replace the control unit:

1. On 1800 series models and 1975 164 models, disconnect the defroster hose, remove the control unit bracket retaining screws, and lower the unit to the floor. On 140 series and 1973-74 164 models, move the passenger's front seat all the way back, unscrew the bolt securing the seat front, move the seat forward while folding the seat bottom to the rear, remove the control unit retaining screws, and draw out the unit.
2. Remove the screw for the cap holding the cable harness to the unit. Pull out the plastic cover strip.
3. Construct a puller out of 5/64 in. (2mm) welding wire (see illustration) to disconnect the main plug contact. Insert the puller in the rear of the control unit and pull out the plug carefully.

To install:

4. Press the plug contact firmly into the new or reconditioned control unit. Fit the plastic cover strip, retaining cap, and screw.



1. Temperature sensor for induction air
2. Air cleaner
3. Throttle valve switch
4. Cold start valve
5. Inlet duct
6. Pressure sensor
7. Control unit (electronic)
8. Battery
9. Fuel tank
10. Fuel filter, suction side
11. Fuel pump
12. Fuel filter, discharge side
13. Triggering contacts in distributor
14. Pressure regulator
15. Injectors
16. Thermal timer contact
17. Idling adjusting screw
18. Temperature sensor for coolant
19. Auxiliary air regulator

Fig. 19 Schematic for the electronic fuel injection system — B20F engine

5. Fit the control unit into place and install its retaining screws. Install the remaining components in the reverse order of removal. Have the mixture adjusted, if necessary.

PRESSURE REGULATOR

The regulator may be adjusted with its adjusting nut. Pinch and disconnect the flexible fuel hose between the pressure regulator and the header pipe and insert a tee fitting and pressure gauge. Tighten the fuel connections and start the engine. Loosen the locknut and adjust the pressure to 28 psi (193 kPa). If the regulator cannot be adjusted properly, it must be replaced. Remove the tee fitting and gauge, and connect the fuel hoses. Replace the regulator as follows:

1. Place pinch clamps on the three fuel hoses connected to the regulator.
2. Loosen the hose clamps and remove the hoses.
3. On 1970-71 models, remove the regulator from its bracket and replace it with a new one.
4. Connect the fuel hoses to the new regulator, tighten the hose clamps, and remove the pinch clamps.
5. Start the engine and check for fuel leaks.

FUEL INJECTORS

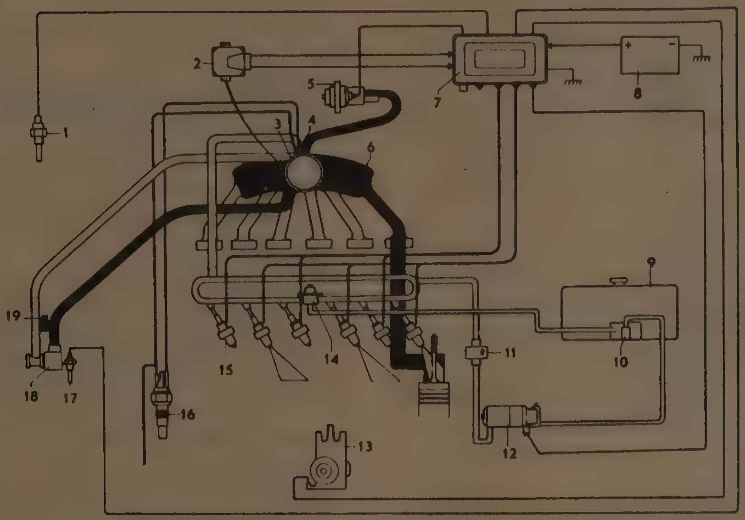
➧ See Figure 22

The fuel injectors may be checked for electrical function and sealing only. To check for electrical function, remove the electrical connection and connect an ohmmeter across the injector terminals. Resistance should be 2.40 ohms at 68°F (20°C).

Do NOT apply 12V current to the injectors. Such voltage would immediately destroy the injector. The internal electric components work on a maximum of three volts.

After following Steps 1 and 3-5 below, simply observe the amount of fuel which leaks from the injector with the fuel hose still connected. Acceptable leakage is 5 drops per minute or about one drop every 12 seconds. Excessive dripping delivers too much fuel; the engine runs too rich. Symptoms similar to flooding a carbureted engine may appear. Remove and replace the injectors.

1. On 164 models, remove the air cleaner.
2. Pinch shut the fuel hose to the header pipe.
3. Loosen the hose clamps for the injectors and lift up the header pipe.



1. Temperature sensor for induction air
2. Throttle valve switch
3. Throttle housing
4. Cold start valve
5. Pressure sensor
6. Inlet duct
7. Control unit (electronic)
8. Battery
9. Fuel tank
10. Fuel filter, suction side
11. Fuel filter, discharge side
12. Fuel pump
13. Triggering contacts in distributor
14. Pressure regulator
15. Injectors
16. Thermal timer contact
17. Temperature sensor for coolant
18. Auxiliary air regulator
19. Idling adjusting screw

Fig. 20 Schematic for the electronic fuel injection system — B30F engine

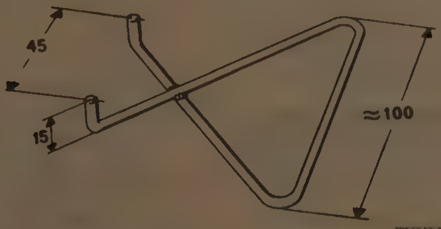
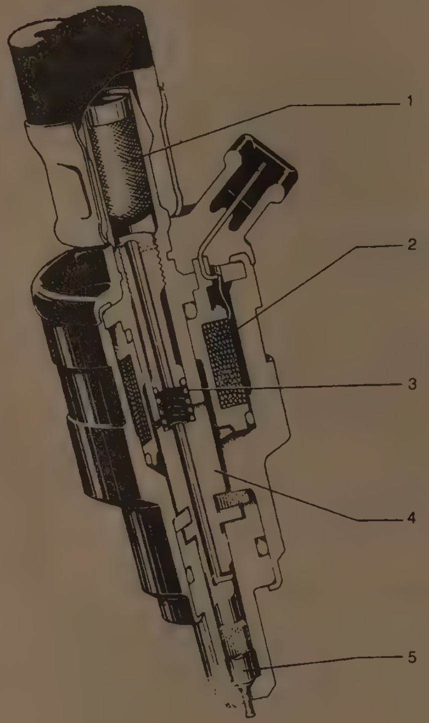


Fig. 21 Acquire or fabricate the puller shown to facilitate removal of the control unit plug contact



1. Filter
2. Magnetic winding
3. Return spring
4. Magnetic armature
5. Sealing needle

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Fig. 22 Cutaway view of the fuel injector

4. Remove the plug contacts from the injectors. Disconnect the cable harness from the distributing pipe.
5. Turn the lockrings on the injectors counterclockwise so that they loosen from their bayonet fittings. Lift out the injectors.

To install:

6. Place the new injectors, with new washers and new rubber sealing rings, in position and secure them by turning the lockrings clockwise.
7. Connect the cable harness at the distributing pipe. Connect the plug contacts to the injectors.
8. Place the header pipe in position, and tighten the hose clamps. Remove the pinch clamps.
9. On 164 models, install the air cleaner.

COLD START VALVE

The cold start valve, mounted on the intake manifold, provides the engine with extr fuel during cold start up. The injection time is governed by the thermal timer which measures coolant temperature and activates the cold start valve electrically. The cold start valve is energized when the temperature of the coolant is below 95°F (35°C). When engaged, the system provides extra fuel for up to 12 seconds, as long as the starter is engaged. To replace the cold start valve:

1. On 164 models, remove the air cleaner.
2. Pinch shut the fuel line to the valve.
3. Remove the plug contact and the fuel hose from the valve.
4. Remove the two retaining screws and the cold start valve from the inlet duct.

To install:

5. Place the new cold start valve in position with packing and install the retaining screws.
6. Connect the plug contact and fuel hose to the valve. Remove the pinch clamp.
7. On 164 models, install the air cleaner.

THERMAL TIMER

The thermal timer is a temperature controlled switch controlling current to the cold start valve. In addition to sensing the temperature of the coolant, an internal circuit heats up when the starter is engaged. After a certain temperature is reached, the control circuit to the cold start valve is disconnected. This prevents delivering excessive amounts of fuel to an engine being cranked for long periods. To replace:

1. Drain the cooling system.
2. Disconnect the plug contacts and unscrew the thermal timer from the cylinder head.
3. Install a new timer and connect the plug contacts.
4. Refill the cooling system.

THROTTLE VALVE SWITCH

The throttle valve switch may be adjusted with an ohmmeter. Connect the ohmmeter to the control unit (contacts 14 and 17 for 4-cylinder, and contacts 9 and 14 for 6-cylinder). Loosen the screws slightly so that the switch may be rotated. Scribe a mark at the upper switch screw on the inlet duct if one is not there already.

Close the throttle valve by turning the switch clockwise as far as it will go. Then, observing the ohmmeter, carefully turn the switch counterclockwise until the ohmmeter registers 0. At this point, the switch is turned a further 1° counterclockwise (½ graduation mark at upper screw), and both switch screws are tightened. Check to make sure that the ohmmeter reading rises to infinity when the throttle valve opens approximately 1°. If it becomes necessary to replace the switch:

1. Disconnect the plug contact from the switch. Remove the two retaining screws and pull the switch straight out of the inlet duct.
2. Fit the new switch to the inlet duct and install the retaining screws. Connect the plug contact.
3. Adjust the switch.

AUXILIARY AIR REGULATOR

The auxiliary air regulator is found at the front of the cylinder head and has a capillary tube extending into the cooling system. Its functional range is from -13°F to +140°F (-25°C to +60°C). Depending on the temperature of the coolant, the unit allows additional air into the intake manifold. As the engine heats up, the capillary tube expands and presses back the regulator slide; at 140°F (60°C), the system is completely closed and no additional air is admitted to the system.

To check the operation of the auxiliary air regulator, start the engine and allow it to reach operating temperature, 176°F (80°C). Make a note of the idle speed and then disconnect the hose between the inlet duct and the regulator. While covering the hose opening with your hand, check to see that the idle speed does not drop significantly under the first reading. A drop in idle speed indicates a leak in the regulator, requiring its replacement. Replace the regulator as follows.

1. Drain the cooling system.

CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Remove the plug contact from the temperature sensor and disconnect the air hoses from the regulator.
3. Remove the two retaining bolts and draw out the regulator.
4. Using a new sealing ring, position the new regulator to the cylinder head and install the retaining bolts.
5. Connect the plug contact and the two air hoses.
6. Refill the cooling system.

INTAKE AIR TEMPERATURE SENSOR

Located in front of the air cleaner, this sensor informs the control unit of changes in air temperature. At air temperatures below 86°F (30°C), the injection interval (duration) increases slightly. To test this sensor, connect an ohmmeter across the terminal pins. According to the air temperature, resistance should be: 440 ohms @ 50°F (10°C); 300 ohms @ 68°F (20°C); 210 ohms @ 86°F (30°C); 160 ohms @ 104°F (40°C). Acceptable range is plus or minus 40 ohms for each listed resistance. To replace the sensor:

1. On 164 models, remove the right drip protection, and the air hose from the right side.
2. Disconnect the four-way plug contact from the sensor.
3. Unscrew the old sensor and install a new one, taking care not to overtighten it.
4. Plug in the four-way contact for the sensor.
5. On 164 models, install the right air hose and drip protection.

COOLANT TEMPERATURE SENSOR

The temperature sensor is located at the front of the cylinder head and informs the control unit of changes in the coolant temperature. This sensor is also tested by checking the resistance with an ohmmeter. Ohm readings will vary with coolant temperature as follows: 3000-4200 ohms @ 50°F (10°C); 2100-3100 ohms @ 68°F (20°C); 1400-2100 ohms @ at 86°F (30°C); 1000-1400 ohms @ 104°F (40°C). Target readings are the middle of the range, but anywhere within the range is acceptable. To replace the coolant sensor:

1. Drain a portion of the cooling system so that the coolant level in the radiator and engine is below the temperature sensor.
2. Disconnect the plug contact from the sensor.
3. Unscrew the old sensor and install a new one with a new sealing ring.
4. Connect the plug contact.
5. Top up the cooling system.

PRESSURE SENSOR

This device interprets changes in intake air pressure and communicates with the control unit. It is from this unit that the control unit gets its sense of engine load. Generally located on the right front wheel well, the sensor contains mechanical components to read air pressure and a small transformer for sending electrical signals to the brain.

➡The terminals should be numbered on the transformer.

Only the transformer can be checked; there are no mechanical repairs for the sensor. Using an ohmmeter, check the resistance between terminals 7 and 15. This measurement of the primary windings should be about 90 ohms. Measure the secondary winding between terminals 8 and 10 and look for about 350 ohms. Any other combination of terminals should yield an infinite resistance, i.e. no connection. If it is necessary to replace the sensor:

1. Disconnect the four-way contact and the air hose from the sensor.
2. Remove the three screws retaining the sensor to the right wheel housing.
3. Transfer the attaching bracket to the new pressure sensor.
4. Position the new sensor to the wheel well and install the retaining screws.
5. Connect the plug contact and the air hose to the sensor.

TRIGGERING CONTACTS

These two contacts are actuated by the distributor camshaft. The electrical message they send to the control unit is used with the air pressure data to determine when injection should begin and how long the injection should last. To inspect or replace the contact unit:

1. Remove the distributor. (See Section 3.)
2. Remove the two screws securing the triggering contacts holder to the distributor and then pull out the holder.
3. Lubricate the fiber pieces of the contact breaker lever on the new holder with silicone cam lobe grease.
4. Check to see that the rubber ring is not damaged. Replace if necessary.
5. Install the new holder in the distributor and tighten the retaining screws.
6. Install the distributor.

Continuous Mechanical Fuel Injection

➧ See Figures 23, 24, 25 and 26

The mechanical Bosch Continuous Injection (CI) fuel system is standard on all gasoline engine 240 and 260 models, 1974 140 models and all 1980 and later models except the B21F-LH and the B23F-LH. It differs from the electric fuel injection (see above) in that injection takes place continuously. Controlled through variation of the fuel flow rate through the injectors, rather than variation of the fuel injection duration, this system has no electronic computer. It is an electromechanical system that will provide suitable air/fuel mixtures to accommodate differing driving conditions.

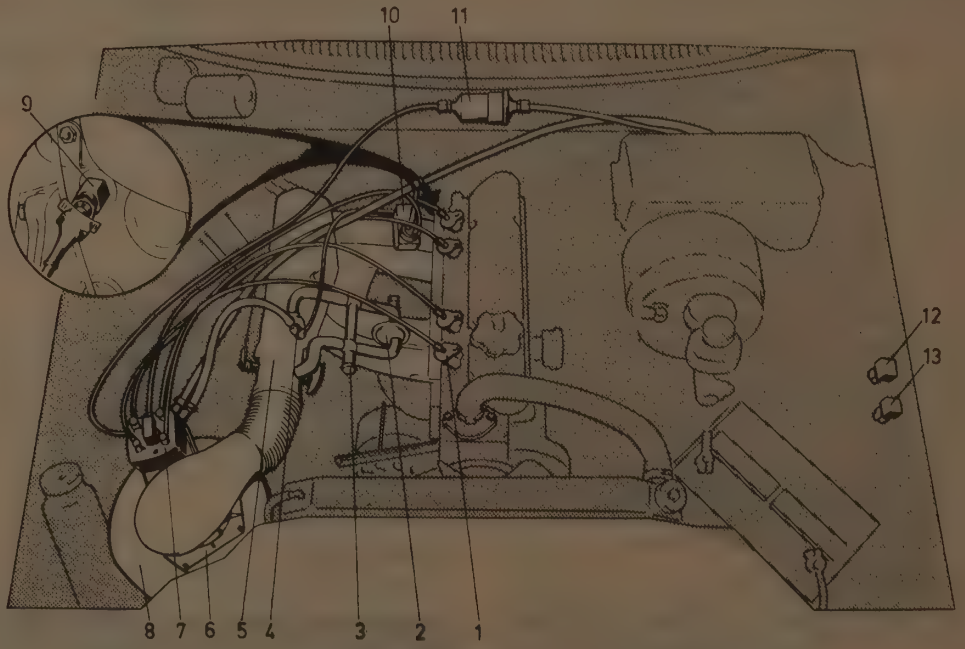
The complete system consists of the following components: air/fuel control unit (housing both air flow sensor and fuel distributor), electric fuel pump (and fuel pressure accumulator), fuel filter, control pressure regulator, continuous fuel injectors, auxiliary air valve, cold start injector, thermal time switch, main relay, and a fuel pump relay.

The heart of the system is the air/fuel control unit. It consists of an air flow sensor and a fuel distributor. Intake air flows past the air cleaner and through the air venturi raising (four cylinder) or lowering (V6) the counterbalanced air flow sensor plate. The plate is connected to a pivoting lever which moves the control plunger in the fuel distributor in direct proportion to air flow.

The fuel distributor, which controls and distributes the amount of fuel to the injectors consists of a line pressure regulator, a control plunger, and pressure regulator valves (one for each injector). The line pressure regulator maintains the fuel distributor inlet pressure at about 65 psi (448 kPa) and will recirculate fuel to the tank if pressure exceeds this value. The control plunger (which is connected to the air flow sensor plate) controls the amount of fuel available to each of the pressure regulator valves. The pressure regulator valves maintain a constant fuel pressure differential (1.4 psi/9.7 kPa)) between the inlet and outlet sides of the control plunger. This is independent of the amount of fuel passing through the valves, which varies according to plunger height.

The injectors themselves are spring loaded and calibrated to open at 47-51 psi (324-352 kPa). They are not electrically operated as on the older electronic fuel injection system.

The control pressure regulator, located on the intake manifold, acts to regulate the fuel/air mixture according to engine temperature. When the engine is cold, the control pressure regulator richens the mixture (4-5 minutes max.). This is accomplished in the following manner; a certain amount of fuel is bled off into a separate control pressure system. The control pressure regulator maintains this fuel at about 52.5 psi (392 kPa). The regulator is connected to the upper side of the fuel distributor control plunger. When the engine temperature is below operating minimum, a bi-metal spring in the regulator



1. Injector
2. Auxiliary air valve
3. Idle adjustment screw
4. Cold start injector
5. Intake manifold
6. Air flow sensor
7. Fuel distributor
8. Air cleaner
9. Thermal time switch
10. Control pressure regulator
11. Fuel filter
12. 13. Safety relay and pump relay

Fig. 23 Location of the CI system components — B20 engine shown

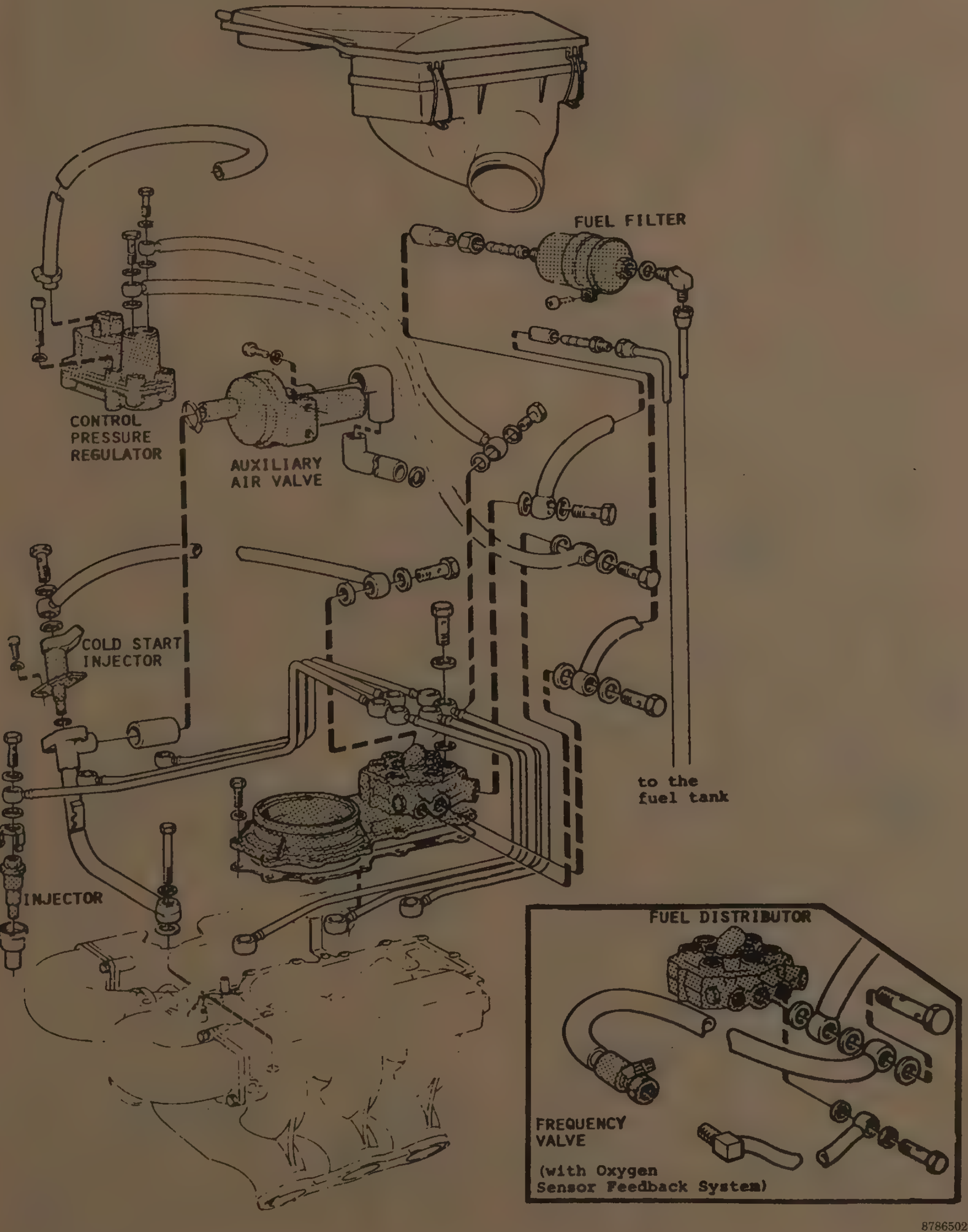

FUEL FILTER
CONTROL PRESSURE REGULATOR
AUXILIARY AIR VALVE
COLD START INJECTOR
INJECTOR
to the fuel tank
FUEL DISTRIBUTOR
FREQUENCY VALVE
(with Oxygen Sensor Feedback System)
87865022

Fig. 24 Exploded view of the continuous fuel injection system (mechanical) — B27F engine. B28F is similar

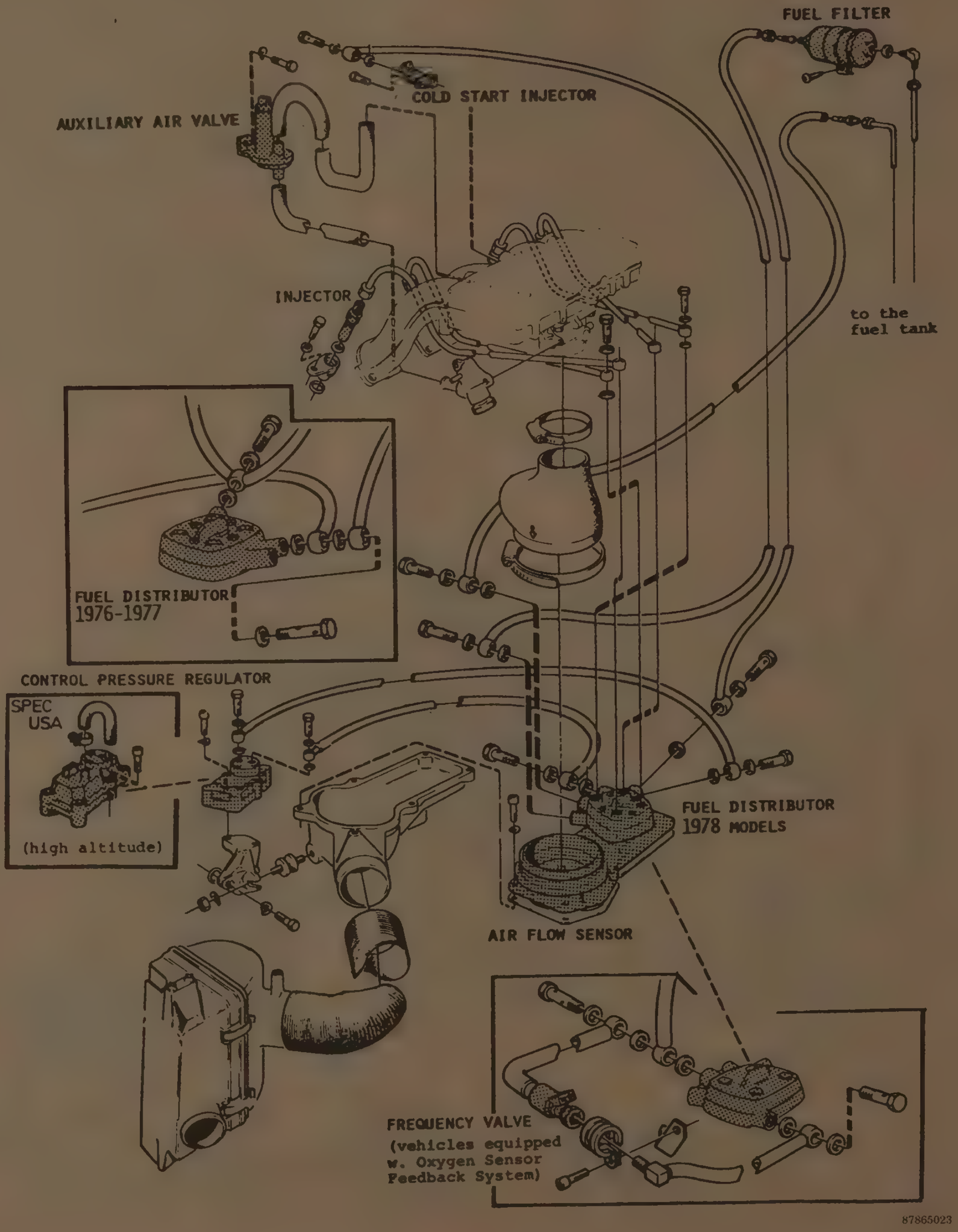

FUEL FILTER
COLD START INJECTOR
AUXILIARY AIR VALVE
INJECTOR
to the fuel tank
FUEL DISTRIBUTOR 1976-1977
CONTROL PRESSURE REGULATOR
SPEC USA
(high altitude)
FUEL DISTRIBUTOR 1978 MODELS
AIR FLOW SENSOR
FREQUENCY VALVE (vehicles equipped w. Oxygen Sensor Feedback System)
87865023

Fig. 25 Exploded view of the continuous fuel injection system (mechanical) — B21F engine

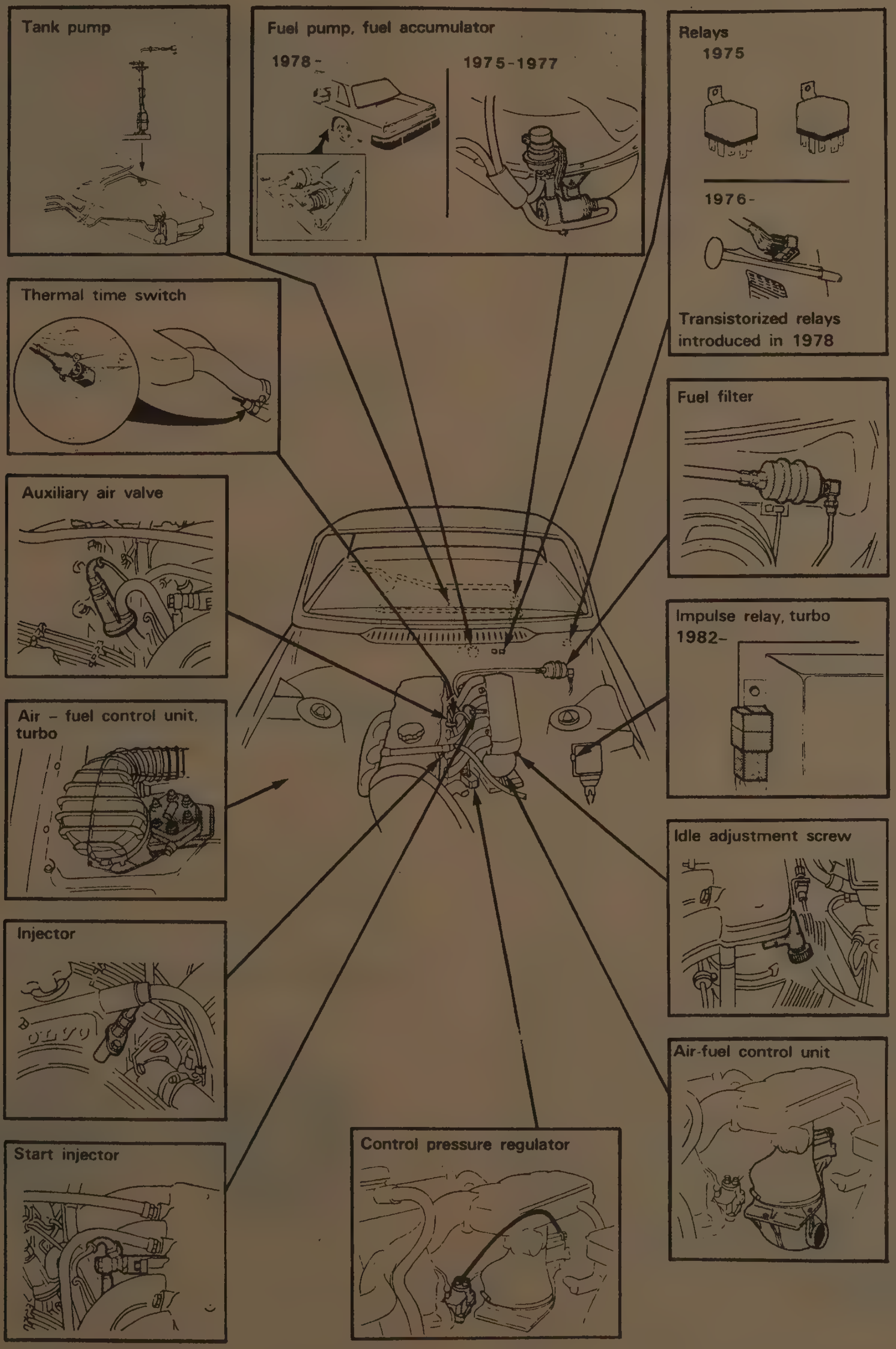

Tank pump
Fuel pump, fuel accumulator
1978-
1975-1977
Relays
1975
1976-
Transistorized relays introduced in 1978
Thermal time switch
Fuel filter
Auxiliary air valve
Impulse relay, turbo 1982-
Air - fuel control unit, turbo
Idle adjustment screw
Injector
Air-fuel control unit
Start injector
Control pressure regulator
87865026

Fig. 26 CI system component location — 240 model shown, others are similar

senses this and reduces the fuel pressure on top of the plunger.

This allows the plunger to rise further and channel more fuel to the regulator valves and injectors, thereby richening the mixture. When the engine warms, the bimetal spring in the regulator increases the pressure to 52.5 psi (392 kPa), leaning the mixture back to its normal operating ratio. On V6 models, a vacuum feature is added to the regulator, whereby low vacuum situations, such as acceleration, temporarily lower the control pressure and richen the mixture. At idle, full throttle, and steady state conditions, the vacuum is high and the mixture returns to normal.

The auxiliary air valve provides extra air to mix with the richer mixture during warm-up, thus raising the engine speed and improving cold start driveability. The auxiliary air valve, which also has a temperature sensitive bimetal spring, works directly with the control pressure regulator. At cold startup, the valve is fully open. As the engine warms, an electric coil slowly closes the valve (4-5 minutes max.), blocking off the extra air and eliminating the fast idle speed.

The cold start injector, located on the inlet duct, sprays extra fuel into the intake air stream (during starter operation) when the engine coolant temperature is below 95°F (35°C). It has a maximum spraying duration of 12 seconds.

The thermal time switch, located on the cylinder head, actuates the cold start injector. Its bi-metal spring senses coolant temperature and an electric coil limits the cold start injector spray to 12 seconds.

The fuel accumulator, located adjacent to the fuel pump, has a check valve which keeps residual fuel pressure from dropping below 28 psi (193 kPa) when the engine or fuel pump are shut off. Therefore, the system is always pressurized, preventing vapor lock in hot start situations.

TESTING & ADJUSTMENT

Air/Fuel Control Unit

RESETTING

➧ See Figures 27, 28, 29 and 30

The air-flow sensor plate adjustment is critical. The distance between the sensor plate and the plate stop must be 0-0.02 in. (0-0.5mm). The plate must also be centered in the venturi, and must not contact the venturi walls. Loosen the plate center when depressed, it should return to its rest position when released.

To check the air-flow sensor contact switch, turn the ignition key to the **ON** position — don't start the motor--and depress (V6) or lift (4-cyl.) the sensor plate by hand. The fuel injectors should buzz, and the fuel pump should activate. If the pump operates, but the injectors do not buzz, check the fuel pressure. If the pump does not operate, check for a short in the air-flow sensor connector. Turn the ignition to **OFF** before performing any diagnostic work.

87863301

Fig. 27 The intake plenum of the air flow sensor plate is located under the engine intake air supply hose — B21FT engine shown

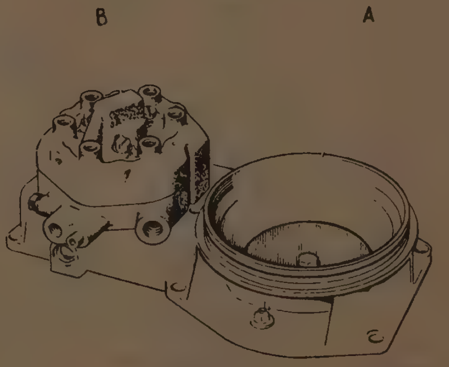


Fig. 28 Six-cylinder air/fuel control unit for CI system — "A" is the airflow sensor, "B" is the fuel distributor

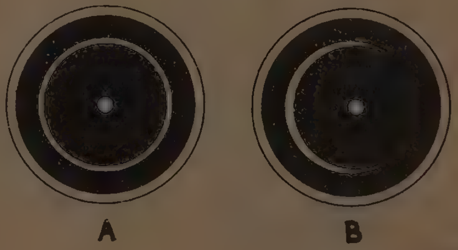


Fig. 29 Center the plate on the air/fuel control unit

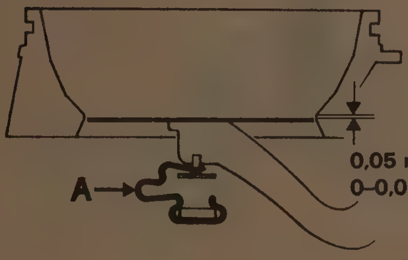


Fig. 30 Adjust the distance between the sensor plate and stop at spring "A" — B21F engines

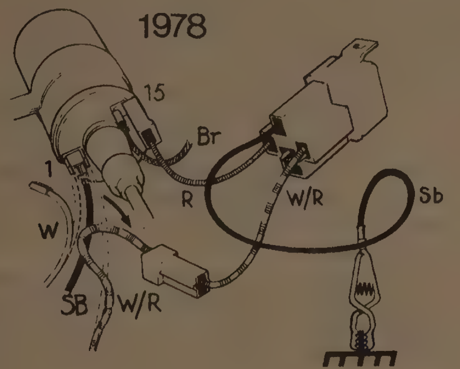


Fig. 31 Attach a test relay on 1978 and later models

Fuel Pump

TESTING

➧ See Figure 31

If a defective fuel pump is suspected, perform this test. With the ignition switch on, disconnect the wire connector at the air flow sensor. The pump should work. If not, check fuse No. 7 (1977) or fuses No. 5 and No. 7 (1976 and 1978 and later) and voltage across auxiliary air valve terminals. Live terminals indicate a faulty fuel pump or wiring.

✻✻WARNING

The use of the correct special tools or their equivalent is REQUIRED for this procedure. A fuel pressure gauge with a three position valve and T-fitting is required to isolate the line, rest, and control pressure readings.

Connect a pressure gauge and T-fitting with 3-way valve inline between the center of the fuel distributor (control pressure fuel line) and the control pressure regulator.

✻✻CAUTION

Disconnect the coil wire (terminal 15) to prevent burning out the coil windings.

Disconnect the wire connectors at the control pressure regulator and auxiliary air valve. Switch on the ignition and disconnect the wire connector at the air-flow sensor on pre-1978 models, attach test relay as shown on 1978 and later models. The fuel pump should start.

Check the line pressure first. With the T-fitting lever pointing to the fuel distributor, check that the line pressure is 64-75 psi (441-517 kPa). If insufficient, check fuel lines for leakage, fuel pump for delivery capacity (25.3 fluid ounces/750 ml in 30 seconds), or low line pressure adjustment. If too high, check for clogged fuel return line or high line pressure adjustment. Line pressure is adjusted along with rest pressure later in this procedure.

Check the control pressure next. With the T-fitting turned at a right angle to the hoses, check the control pressure. Depending on coolant temperature, the control pressure will be somewhere between 18-55 psi (124-379 kPa), lower for cool temperatures, higher for warm temperatures. If the control pressure is insufficient, try a new pressure regulator. If the pressure is too high, check for a clogged fuel return line, or try a new control pressure regulator. Reconnect the control pressure regulator electrical connector.

After 4-5 minutes, the pressure should equal 44-55 psi (303-379 kPa). If not, disconnect the electrical connector at the control pressure regulator and check with a 12V test light across the terminals. No voltage indicates a defective (open) wire. Voltage indicates a possible faulty regulator. Then check across the terminals with an ohmmeter. Resistance indicates corroded terminals. No resistance indicates a defective control pressure regulator.

➡On the B28F engine, the control pressure regulator is equipped with two resistor heaters which are wired in parallel in the regulator wiring circuit. One of the heaters is switched off at temperatures above 60°F (15°C). Correct resistance on this regulator is: 32-38 ohms below 55°F (13°C); 16.5-19.5 ohms above 65°F (18°C).

The vacuum function of the control pressure regulator on the V6 engine is checked later in this test.

The auxiliary air valve is checked next. Disconnect the auxiliary air valve hoses. Using a dentist's mirror or similar and a flashlight, check that the valve is partly open at room temperature. Reconnect the wire connector at the valve and, after 4-5 min., the valve should be fully closed. If not, tap on valve and check again. If tapping closes the valve, the valve is OK (engine vibrations will close it in normal operation). If the auxiliary air valve still does not close, disconnect the connector and check the voltage across the wire connector terminals with a 12V test light. No voltage indicates a defective circuit. Next, check across the auxiliary air valve terminals with an ohmmeter. Correct resistance is 40-60 ohms. No resistance indicates a faulty auxiliary air valve.

Check the rest pressure. Connect the wire connector to the air-flow sensor to stop the fuel pump. With the pump stopped, and the pressure gauge T-fitting lever at a right angle to the fuel lines, check that the rest pressure is 24 psi (165 kPa), dropping to no less than 14 psi (96.5 kPa) after 10 minutes. The rest pressure and line pressure are adjusted simultaneously by inserting or removing shims between the regulator plunger and plunger cap on the side of the fuel distributor. Shims are available in 0.1mm and 0.5mm sizes. A 0.1mm shim makes a 0.8 psi (5.5 kPa) difference, and a 0.5mm shim makes a 4.3 psi (29.6 kPa) difference on both rest and line pressure.

If the rest pressure drops noticeably within one minute, check for defective control pressure regulator, leaky line pressure regulator or O-ring, a defective fuel pump check valve, or some external fuel leak.

The vacuum function of the V6 control pressure regulator is checked with the pressure gauge and T-fitting installed, and all electrical connectors installed. On a running, warm engine, with the tee fitting positioned at a right angle to the fuel hoses, fuel pressure should be 50-55 psi (345-379 kPa). When the vacuum hose is disconnected at the regulator, the pressure should drop to 44-50 psi (303-345 kPa). If not, the regulator is defective.

Cold Start Injection

TESTING

- **See Figure 32**

Remove the cold start injector from the intake manifold and hold it over a container. For a cold engine — coolant temperature at or less than 90°F (32°C) — the injector should spray during starter operation (max. 12 seconds). If not, check the voltage between the terminals of the injector when the starter is on. Voltage indicates a bad cold start injector. No voltage indicates a faulty thermal time switch or wiring.

With the starter off, disconnect the wire connector at the air-flow sensor on pre-1978 models and attach the test relay as shown (1978 and later models) to operate the fuel pump. Check for cold start injector leakage. Maximum allowable leakage is one drop per minute, less is desirable.

Thermal Tim Switch

TESTING

Remove the cold start injector and place over a beaker. With the engine fully warmed up — coolant temperature over 95°F (35°C) — the injector should not operate. If it does, the thermal time switch is defective. Reminder: on a cold engine, the start injector should not inject fuel for more than 12 seconds during starter cranking. If it does, the thermal time switch is defective.

Continuous Fuel Injection

TESTING

- **See Figures 33, 34 and 35**

The injectors are simple spring-loaded atomizers, designed to open at 47-51 psi (324-351 kPa) on 1974-78 models and 50-54 psi (345-372 kPa) on 1979 and later models. Critical factors are spray pattern, fuel spray quantity, and leakage after the engine is shut off.

To check spray pattern, remove the injectors, one at a time, and hold over a container. Switch the ignition key ON and disconnect the connector at the air-flow sensor to activate the fuel pump. Move the air-flow sensor plate. The injector should

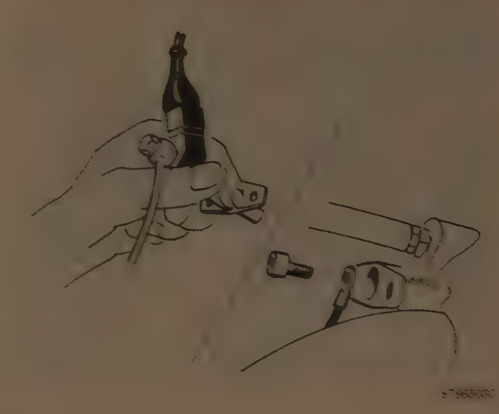


Fig. 32 Remove the cold start injector as shown

Fig. 34 Always inspect the rubber seals and replace, if damaged or worn in any way

Fig. 33 When removing the fuel injectors be very careful not to strip the fittings — a line wrench is usually best

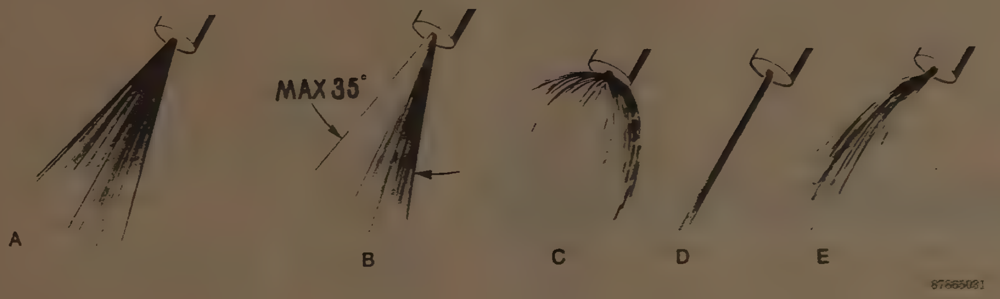


Fig. 35 Examples of injector spray patterns. "A" is proper, "B" is acceptable, "C," "D," and "E" are not acceptable — the injector must be replaced

provide a healthy dose of uniformly atomized fuel at a 15-52° angle in a cone shaped pattern.

To check injection quantity, connect the removed injectors via hoses to 4 (or 6) equal sized containers. Switch on the ignition. Disconnect the connector at the airflow sensor to activate the fuel pump. Run the pump for approximately 30 seconds to pressurize the system. Reconnect the connector to stop the fuel pump. Lift (4-cylinder) or depress (V6) the air-flow sensor plate halfway until one of the beakers fills up. Compare the fuel levels in the containers. If the injection quantity deviates more than 20% between injectors, isolate problem by swapping the lowest and highest quantity injectors and repeating the test. If the same injector still supplies less, clean or replace that injector and fuel supply line. If the other injector is now faulty, the fuel distributor is defective.

The check for injector leak-down (when closed) can now be conducted. Injector leakage beyond slight seepage may be due to the air-flow sensor plate being set to an incorrect height, seizing of fuel distributor plunger, or internal leaks in the fuel distributor. Connect the airflow sensor connector to deactivate the fuel pump and switch off the ignition. Check for injector leakage at rest pressure. Move the sensor plate to open the fuel distributor slots. Maximum permissible leakage is one drop per 15 seconds. If all injectors leak, the problem may be excessive rest pressure.

Throttle Linkage

ADJUSTMENT

On all models, make sure the throttle valve(s) are closed when in the idle position and that they open completely when the accelerator is floored. On the B27F, B28F and B280F engines the throttle valves are located behind the front manifold pipe.

Disconnect the link rod between the throttle valve pulley and the throttle valve, then reconnect it: reconnecting the link should not move the pulley at all. If it does, adjust the link rod at its threaded ends. After reconnecting the link, have an assistant floor the accelerator pedal: the pulley should rotate and its arm should touch the full throttle stop. If the arm does not touch the stop, adjust the cable at its plastic adjuster. Release the throttle cable and make sure it returns to the idle position. Recheck the link rod.

➡To adjust the automatic transmission kickdown cable see Section 7.

CONSTANT IDLE SPEED SYSTEM

➧ See Figures 36 and 37

This system, introduced in 1981, controls the engine idle speed by allowing a controlled amount of air to bypass the throttle valve. It is used on engines with both mechanical and LH-Jetronic electronic fuel injection systems.

➡The Volvo CIS system is an idle air bypass valve. It is not to be confused with the Bosch Continuous Injection System (also CIS), or any of its variants found on many Volvo models.

There are five main components in the constant CIS system:

- The Electronic Control Unit (ECU) processes information from the sensors about engine speed, engine temperature and throttle position. The ECU signals the Air Control Valve to regulate air flow.
- The Air Control Valve, an ECU controlled valve that rotates open or closed to allow more or less air to bypass the throttle valve.
- A micro-switch at the throttle which signals the ECU as the throttle goes back to idle.
- The ignition coil, which provides information to the ECU on engine speed.
- The coolant temperature sensor, which allows the ECU to increase the idle speed when the engine is cold and decrease the idle speed as the engine warms up.

On 1982 and later CIS systems, a micro-switch in the air conditioning control unit signals the ECU to set a higher idle speed when the air conditioning is turned on; this improves air conditioner operation and and eliminates some idle vibration.

On all models except the 760 GLE, the ECU is mounted inside the right door on the kick panel; on the 760 GLE, it is located inside the left door. Air control valves are located next

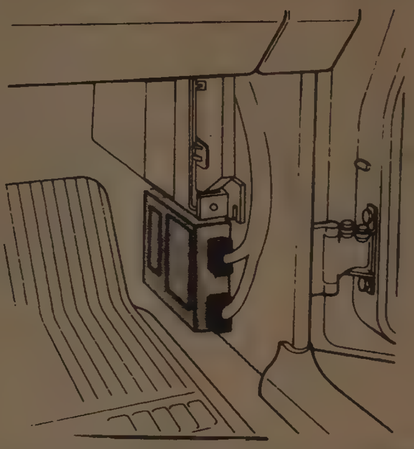


Fig. 36 CIS system ECU location. For 760 GLE models, look for the ECU on the driver's side kick panel

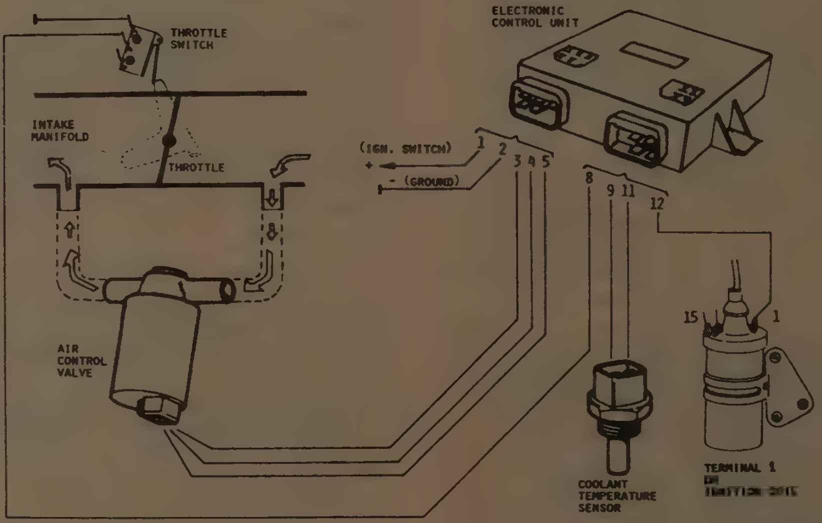

THROTTLE SWITCH
INTAKE MANIFOLD
THROTTLE
AIR CONTROL VALVE
ELECTRONIC CONTROL UNIT
(IGN. SWITCH)
+
- (GROUND)
1
2
3
4
5
8
9
11
12
15
1
COOLANT TEMPERATURE SENSOR
TERMINAL 1
ON
IGNITION COIL
87865032

Fig. 37 Constant Idle Speed components

to the intake chamber on the B21, B23, and B28 V6; on the B21F Turbo, the valve is located under the front side of the intake manifold.

Troubleshooting

➧ See Figures 38, 39, 40, 41, 42, 43 and 44

Eliminate all other possible systems faults before investigating faults in the CIS system. Consult the accompanying chart for possible reasons for an incorrect idle speed.

A common source of problems in the CIS system may be the wires and/or connectors.

There are two connectors, blue at top and black on bottom, at the ECU, and two other ECU connectors at the center and right hand side of the firewall. The air control valve also has a connector at the valve.

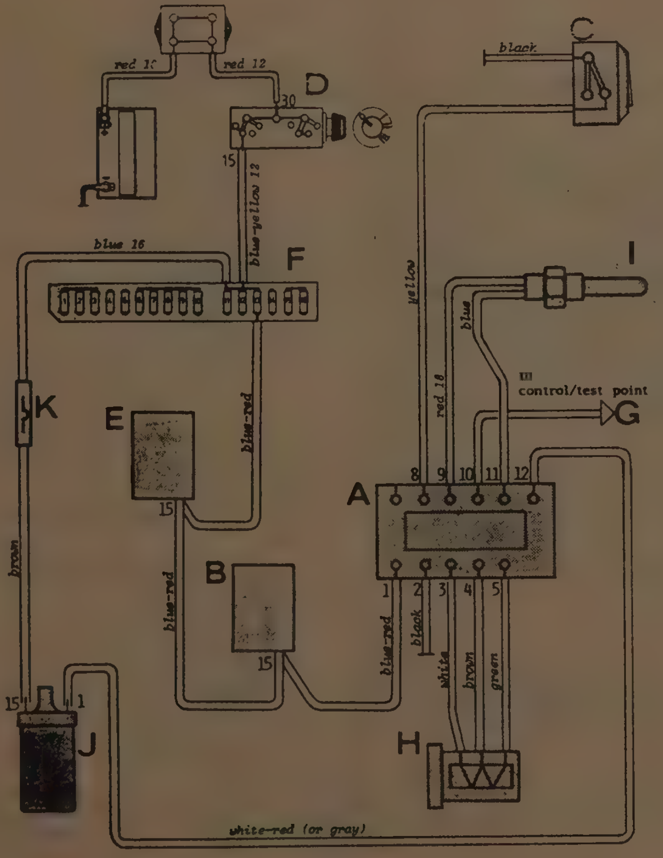
If the engine idle speed is considerably lower than specified, check the engine vacuum hoses for possible obstructions. The air control valve can be become stuck or obstructed by deposits from the PCV valve and system.

A good quality volt-ohmmeter, with a range of 0 to approximately 20 volts is necessary to test the CIS system on all models. It is also helpful to have a test light (the type with a pointed contact on the bulb side and an alligator clamp on the other) as this uses more current then a volt-ohmmeter and might in some cases reveal a bad connection better. A tachometer is necessary as is a supply of jumpers, pieces of wire with connectors or alligator clips on both ends. Jumpers are used to connect two terminals of a circuit. It's extremely handy to buy or make jumpers from various colors of wire. Circuits can then be visually identified quickly.

****WARNING**

Although the CIS system voltage and currents are low, DO NOT press in the test point between the terminal contacts; just TOUCH the test point to them. Otherwise, the terminal contacts may be damaged.

Most of the common faults in the CIS system are bad connections in the multi-pin connectors on the firewall, at the ECU module or at the coolant temperature sensor. If the ECU is not



Fuse No. 13:
Instruments
Turn signals
Seat belt warning
CIS System

Legend:
A ECU (Electronic Control Unit)
B Seat belt reminder unit
C Throttle switch
D Ignition switch
E Fuel pump relay
F Fuse box
G Control/test point
H Air control valve
I Coolant temperature sensor
J Ignition coil
K Ballast resistor

Fig. 38 CIS wiring schematic — B28F engines

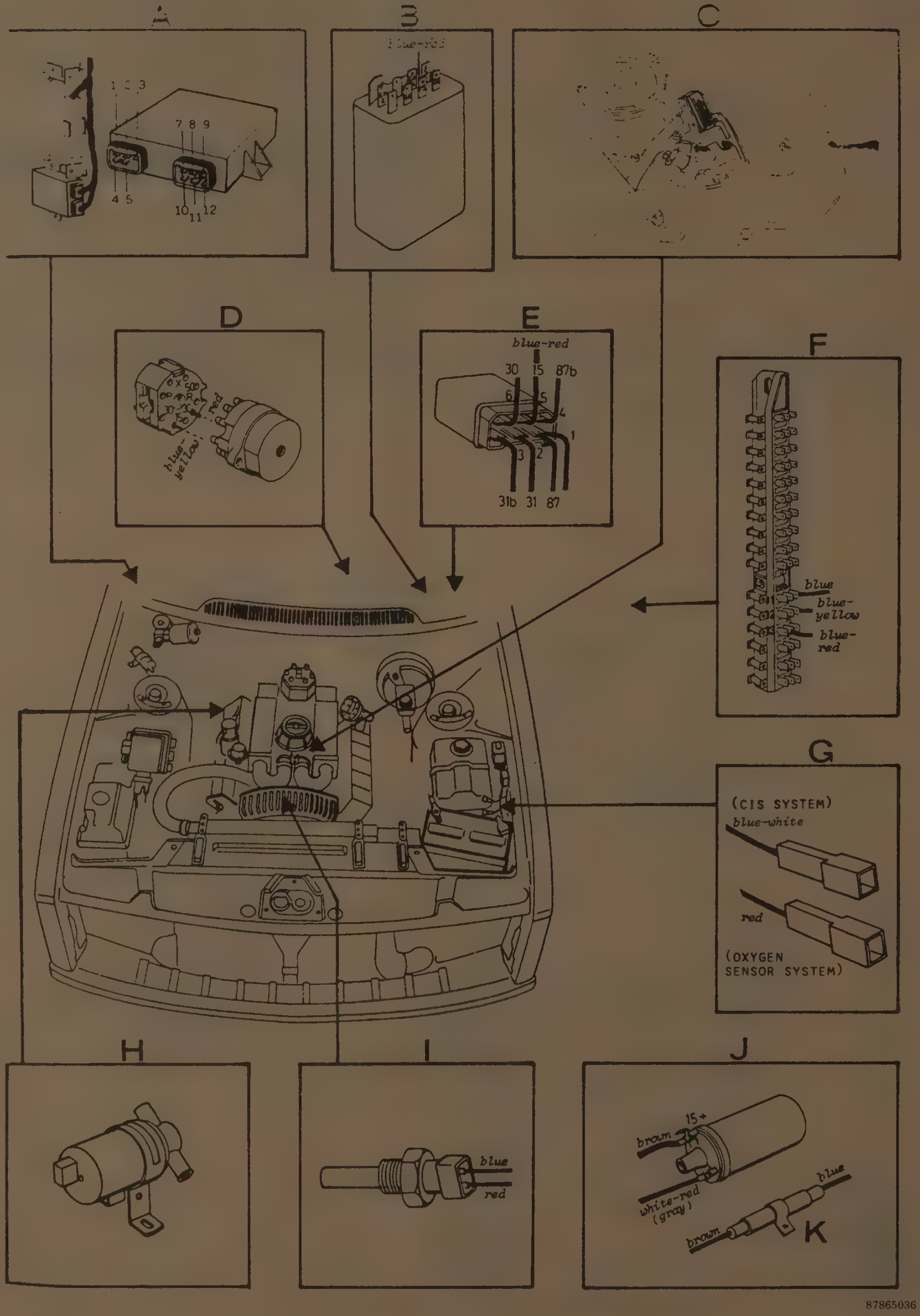

A
1 2 3
7 8 9
4 5
10 11 12
B
blue-red
C
D
red
blue-yellow
E
blue-red
30 15 87b
6 5 4
1
3 2
31b 31 87
F
blue
blue-yellow
blue-red
G
(CIS SYSTEM)
blue-white
red
(OXYGEN SENSOR SYSTEM)
H
I
blue
red
J
15+
brown
white-red (gray)
blue
brown
K
87865036

Fig. 39 Location of CIS components — B28F engines

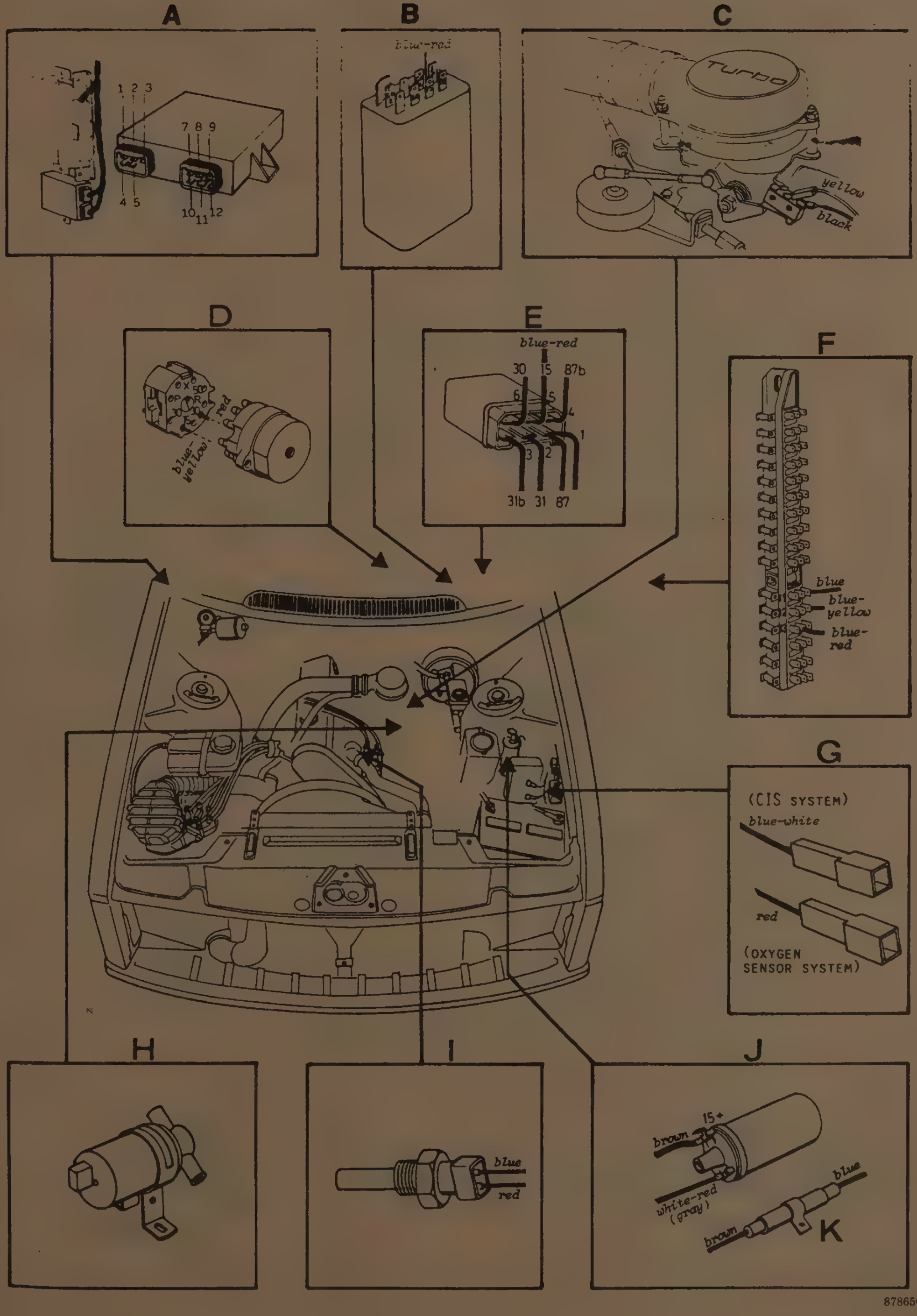

A
1 2 3
7 8 9
4 5
10 11 12
B
blue-red
C
Turbo
yellow
black
D
red
blue-yellow
E
blue-red
30 15 87b
6 5 4
1
3 2
31b 31 87
F
blue
blue-yellow
blue-red
G
(CIS SYSTEM)
blue-white
red
(OXYGEN SENSOR SYSTEM)
H
I
blue
red
J
15+
brown
white-red (gray)
blue
brown
K
87865037

Fig. 40 Location of CIS components — B21F turbo engines

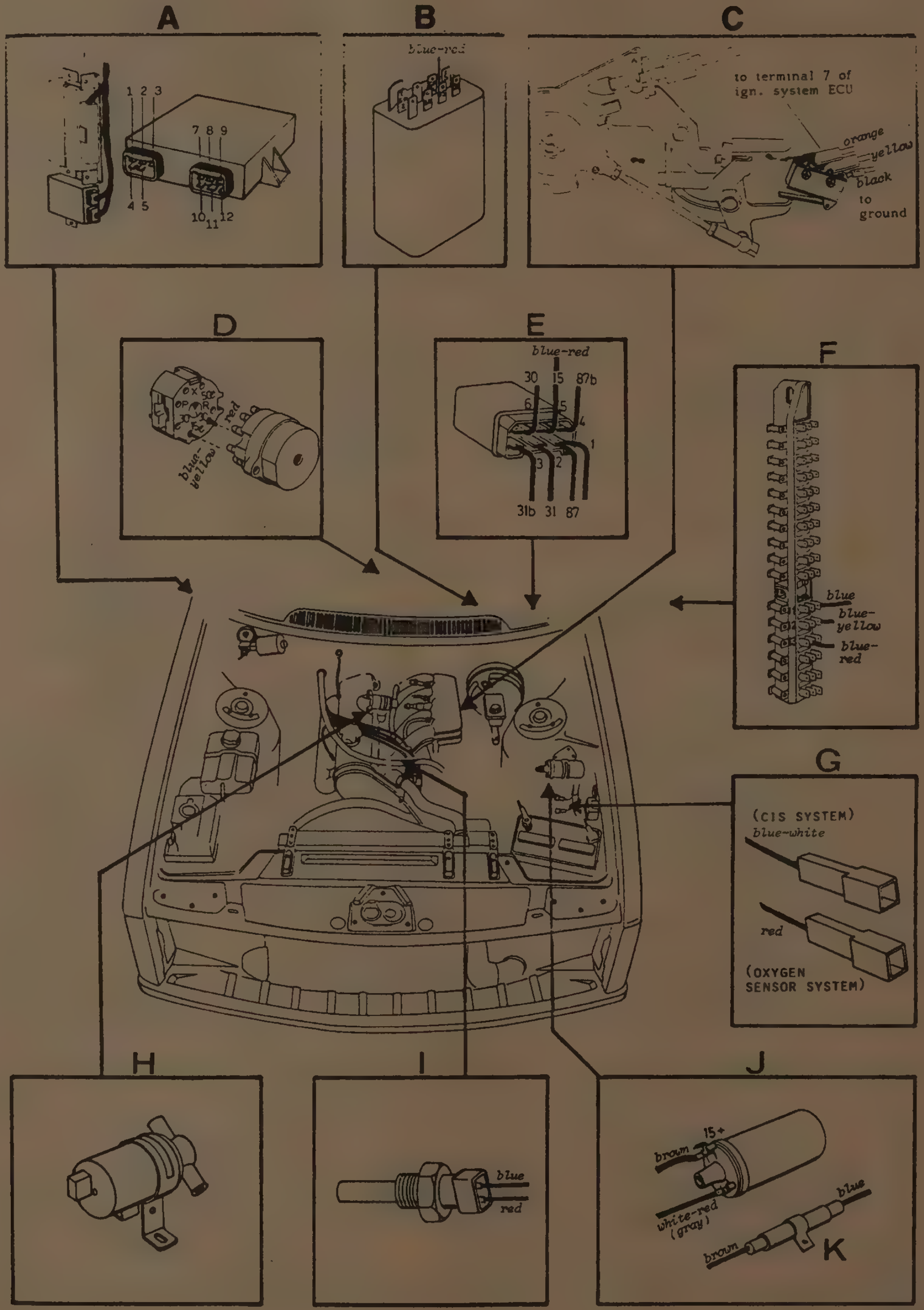

A
1 2 3
7 8 9
4 5
10 11 12
B
blue-red
C
to terminal 7 of ign. system ECU
orange
yellow
black
to ground
D
red
blue-yellow
E
blue-red
30 15 87b
6 5 4
1
3 2
31b 31 87
F
blue
blue-yellow
blue-red
G
(CIS SYSTEM)
blue-white
red
(OXYGEN SENSOR SYSTEM)
H
I
blue
red
J
15+
brown
white-red (gray)
blue
brown
K

Fig. 41 Location of CIS components — B21F engines

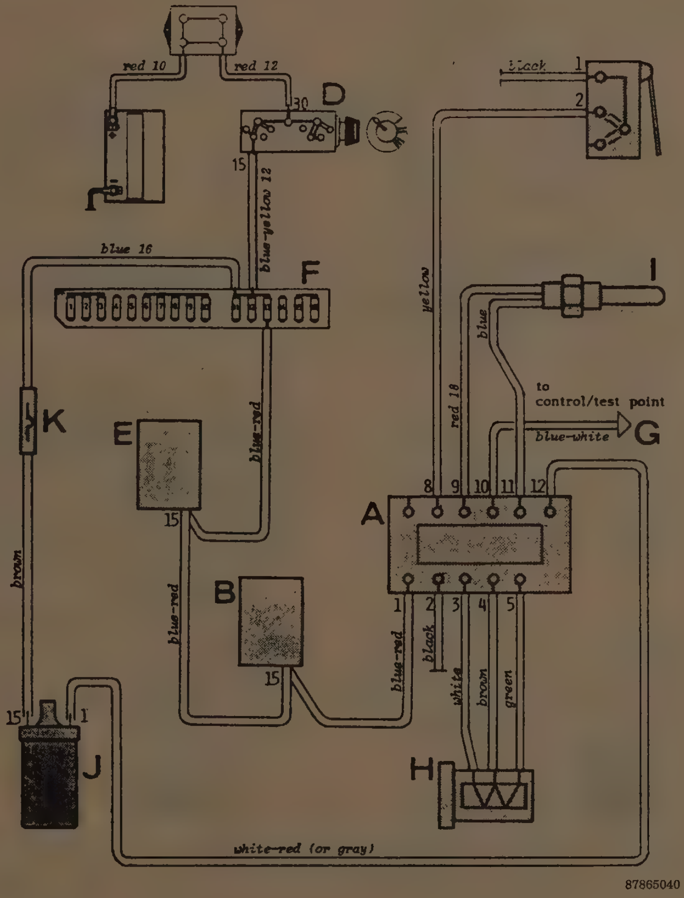

red 10
red 12
30
D
15
blue-yellow 12
black
1
2
blue 16
F
yellow
I
blue
red 18
to
control/test point
blue-white
G
K
E
blue-red
15
A
8
9
10
11
12
1
2
3
4
5
B
blue-red
15
black
blue-red
white
brown
green
brown
15
1
J
H
white-red (or gray)
87865040

Fig. 42 CIS wiring schematic — B21F turbo engines

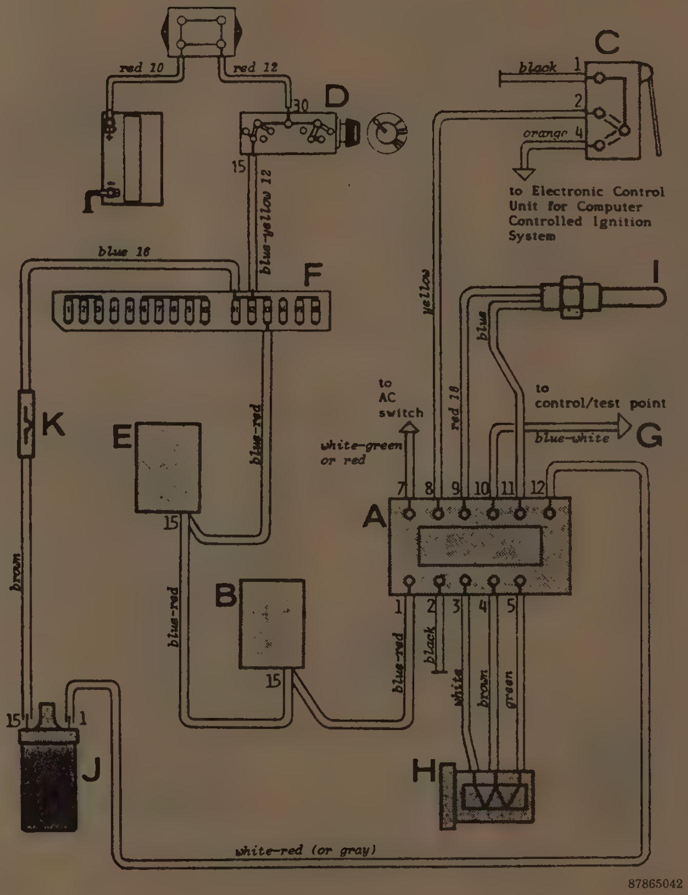

red 10
red 12
30
D
15
blue-yellow 12
C
black 1
2
orange 4
to Electronic Control Unit for Computer Controlled Ignition System
blue 16
F
I
yellow
blue
to AC switch
to control/test point
red 18
blue-white
G
white-green or red
K
E
15
blue-red
7
8
9
10
11
12
A
1
2
3
4
5
B
blue-red
15
blue-red
black
white
brown
green
brown
15
1
J
H
white-red (or gray)
87865042

Fig. 43 CIS wiring schematic — B21F

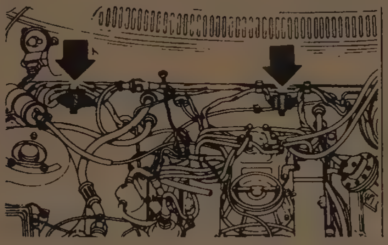


Fig. 44 CIS system firewall connectors

getting correct data from the sensors, it cannot respond properly to the engine conditions of the moment.

➡To prepare for the test, remove the panel that covers the ECU on the kickpanel, and disconnect both connectors at the ECU. Switch the ignition ON, except where noted.

CURRENT SUPPLY

The terminal numbers are marked on the side of the ECU. With the ignition ON, terminal 1 is positive (+) and energized from the ignition switch. Terminal 2 is negative (-) and ground. Connect the voltmeter or test lamp across terminals 1 and 2 in the connector; the voltmeter should read battery voltage and the test lamp should be fully illuminated. If there is no reading, first check an alternate ground, then check fuse No. 13 in the fusebox.

THROTTLE SWITCH (MICRO-SWITCH)

▶ See Figures 45 and 46

Switch the ignition **OFF**. Connect the ohmmeter test leads across terminal 8 (blue connector) and terminal 1 (black connector). Check the accompanying chart for ohmmeter and test lamp results. If the readings are incorrect, adjust the system according to the instructions below for your particular model.

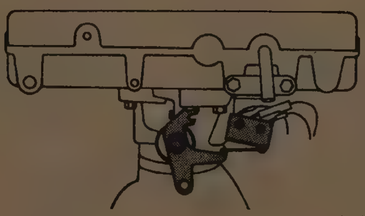


Fig. 45 The CIS throttle micro-switch is located on the throttle linkage

COOLANT TEMPERATURE SENSOR

▶ See Figures 47 and 48

Use the ohmmeter to test coolant temperature sensor resistance. Connect the meter across terminals 9 and 11 of the connectors. Consult the adjacent charts for resistance readings at specific temperature.

IGNITION SIGNAL

Connect the tachometer across terminal 12 and any ground point. Start the engine. The tach should show engine speed; if the reading is incorrect or there is no reading at all, check the connectors on the firewall for good contact.

AIR CONTROL VALVE

Connect a jumper wire across terminals 4 and 1, and another jumper across terminals 5 and 2. Start the engine. A high idle speed of 1600 to 2400 rpm should be obtained — this indicates that the valve is working properly. If the engine does not develop that high idle speed, the air control valve may be defective. If no fault is found with the air control valve, try a new ECU. Always check all connectors for corrosion and secure fit. Reconnect all connectors and check the overall operations of the CIS system.

FULL THROTTLE ENRICHMENT SWITCH

➡The B28F V6 is equipped with two micro-switches actuated by throttle control. The second micro-switch closes a Lambda-sond (the oxygen sensor) circuit at full throttle to provide richer air/fuel mixture at maximum acceleration. Vehicles sold in high altitude areas have this switch disconnected.

1. To adjust the switch, loosen the micro-switch retaining screws. Turn the switch sideways. The test light should come on, then go out $^{3}/_{32}$ in. (2.5mm) before the pulley touches the full throttle stop. Reposition the switch as needed and tighten the retaining screws.
2. To check full throttle enrichment switch operation, disconnect the green wire at the micro-switch. Connect a test light between the micro-switch terminal and the positive battery terminal.
3. Turn the pulley slowly to the full throttle stop. The test light should light up $^{5}/_{32}$-$^{1}/_{32}$ in. (4mm to 1mm) before the pulley touches the stop. Adjust the switch as necessary and reconnect the wiring.

LH-Jetronic, LH-II Jetronic and LH-Jetronic 2.2 Fuel Injection Systems

▶ See Figure 49

The Bosch LH-Jetronic electronic fuel injection system became available on the B21F-LH engine in 1982 and on the B23F-LH in 1983. The complete system contains the following components: L-Jetronic Electronic Control Unit (ECU), airflow sensor, system relay, fuel pump relay, Lambda-Sond oxygen sensor, vacuum switch, electric fuel pump, coolant temperature sensor, fuel injectors, and the electronic control unit terminal

Throttle Pedal Not Depressed (Idle Position)

1981 models:		
B21F, all	infinite resistance	test lamp NOT illuminated
B28F	zero resistance	test lamp illuminated
1982 models:		
B21F, all	infinite resistance	test lamp NOT illuminated
B28F	infinite resistance	test lamp NOT illuminated
1983 models:		
B21F, all	infinite resistance	test lamp NOT illuminated
B23E	infinite resistance	test lamp NOT illuminated
B28F	infinite resistance	test lamp NOT illuminated

Throttle Pedal Depressed (Above Idle Position)

1981 models:		
B21F, all	zero resistance	test lamp illuminated
B28F	infinite resistance	test lamp NOT illuminated
1982 models:		
B21F, all	zero resistance	test lamp illuminated
B28F	zero resistance	test lamp illuminated
1983 models:		
B21F, all	zero resistance	test lamp illuminated
B23E	zero resistance	test lamp illuminated
B28F	zero resistance	test lamp illuminated

87865041

Fig. 46 Micro-switch test lamp results

for the Constant Idle Systems (CIS) if equipped. On the 1983 and later B23F-LH, the fuel injection and the CIS (constant idle speed) systems are both controlled by the same Electronic Control Unit mounted on the right side kick panel.

LH is an abbreviation of a German term which means "hot wire air mass meter." All the LH systems work on the principle of controlling injector duration, but instead of an air flow sensor flap to measure intake air quantity, these systems use a heated platinum wire to measure the air mass. In this manner, altitude influences are eliminated.

A very thin platinum wire is stretched across the air intake opening in the air-flow meter and forms part of a bridging circuit. The intake air flowing over the heated wire cools the wire, changing its electrical resistance according to the temperature. An electronic amplifier instantly responds to any such change and regulates the current to the wire so as to maintain it at a virtually constant temperature. The current necessary to maintain the wire temperature is the measure of the the air mass flowing into the induction system. This measurement is used by the ECU to determine the injector duration (opening time).

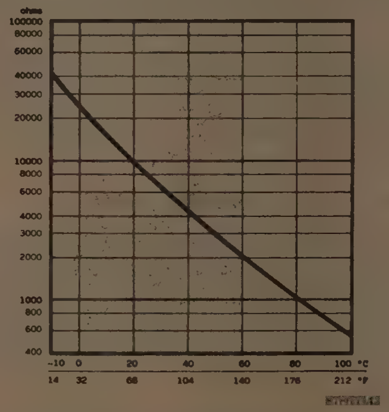
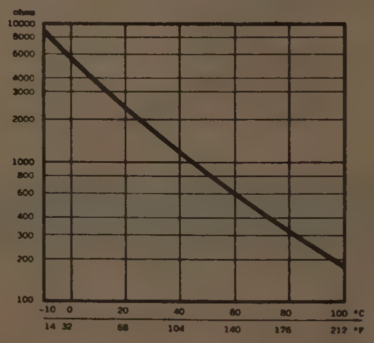
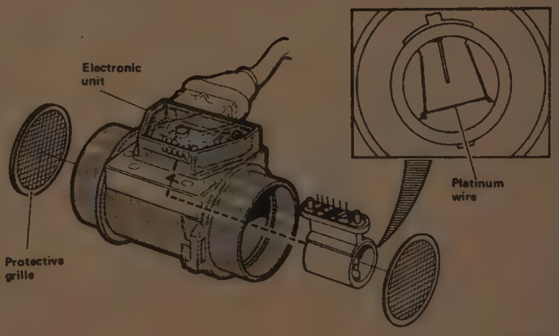


Fig. 47 Test the coolant temperature sensor by checking resistance versus temperature — 1981 B21F and 1981-82 B28F engines



87865044

Fig. 48 Test the coolant temperature sensor by checking resistance versus temperature — 1982 B21F engines



87865045

Fig. 49 Exploded view of the LH-Jetronic air mass meter

Because dirt and impurities may accumulate on the wire and affect the voltage signal, the system is designed to clean the wire each time the engine is shut off. When the engine stops, the wire is heated to 1100-1900°F (593-1,038°C) for less than one second. This burns off any impurities which could cause false readings.

TESTING & INSPECTION

See Figures 50, 51, 52 and 53

The components within the fuel injection system are generally very reliable. Outright failure is not common, although reduced function may occur as a result of age and wear. Before jumping into the injection system and its very expensive pieces, check everything else which influences the system. The LH systems depend heavily on all other components being correct.

It is essential that compression, valve clearance, vacuum routing and flow, and throttle settings be checked and repaired if necessary. Spark plug wires, distributor cap, air filters and electrical connections (including blown fuses) can also cause you to look in the wrong place. A flaw in either the crankcase or evaporative emissions controls can cause hours of misdirected investigation. Simply stated, check the easy things first — repairing a loose ground connector can save you hundreds of dollars.

The fuel injection system is repaired simply be replacing the defective component. There are some adjustments that can be made to some components, but these require a high level of experience and special test equipment. To make resistance checks, use an ohmmeter and for continuity checks, a 12V test light. If the control unit is defective, return it to a qualified repair agency and install a new unit.

It is impossible to test the operation of the ECU without very expensive testing equipment. The easiest way to diagnose a failed ECU is to eliminate all other possibilities by testing the circuits it controls. If all the controlled circuits check good and a performance problem is still evident, the controller must be bad.

➡ALL OF THE FOLLOWING TESTS ARE PERFORMED WITH THE HARNESS DISCONNECTED FROM THE ECU UNLESS STATED OTHERWISE. THE IGNITION SWITCH MUST BE OFF WHEN REMOVING OR INSTALLING THE CONNECTOR.

1. With the ignition **OFF**, remove the right side kick panel and any necessary trim pieces, sill moldings, etc.
2. Carefully release the catches on the ECU and pivot the connector down and away. The connector should come free of the box. If it doesn't, check for the cause of interference; don't force anything.
3. With the connector free, remove the small retaining screws in the connector case. Gently slide the cover a few inches back along the cable. This exposes the body of the connector.
4. The connector numbers are on the body of the connector. Notice the rows of square or rectangular holes along the side of the connector body. These are where you insert the probes of the volt-ohmeter. DO NOT insert the test probes into the front of the connector; this can damage the pins and induce other faults. When testing through the side holes, use only enough pressure to make good contact.
5. When reassembling, work carefully and do not force the body of the plug into the cover. Make sure the wires are not crimped or under undue pressure.

System Grounds

➡The terminals should be numbered (embossed on the plastic housing) on the ECU in order to allow this test to be performed.

Connect the ohmmeter to a known ground and individually check terminals 11 and 25. On LH-2.2 systems, also check terminals 5 and 19. Resistance should be nearly zero in all cases. If ground checks show high resistance, check the ground connections at the intake manifold.

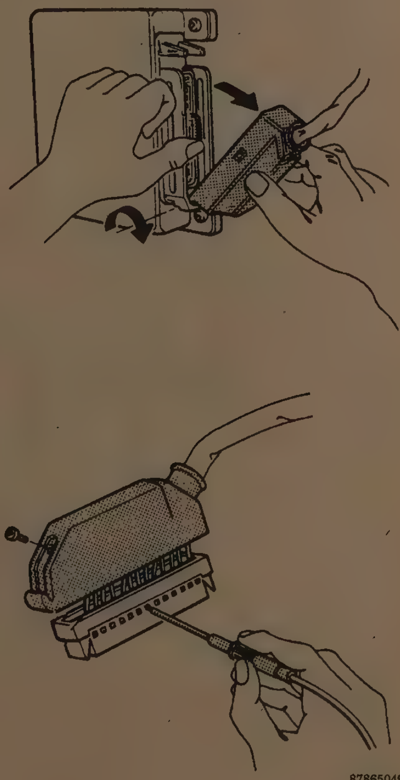
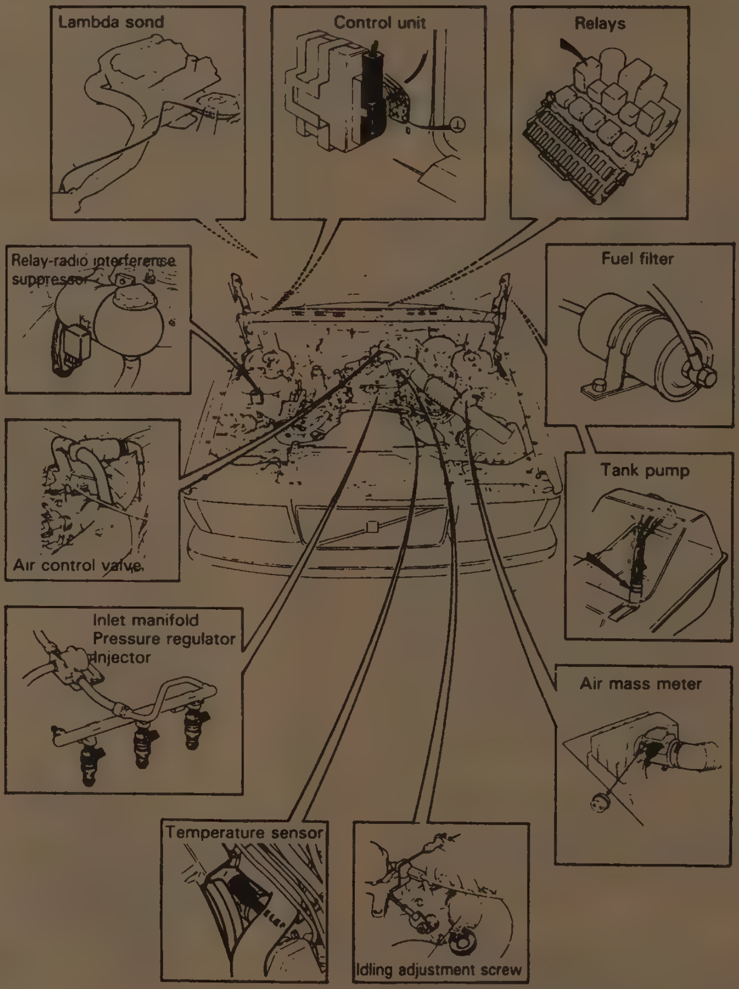


Fig. 50 Be extremely careful when removing the ECU connector for testing


Lambda sond
Control unit
Relays
Relay-radio interference suppressor
Fuel filter
Air control valve
Tank pump
Inlet manifold
Pressure regulator
Injector
Air mass meter
Temperature sensor
Idling adjustment screw

87865046

Fig. 51 Location of LH-Jetronic 2.2 components — B280E/F engines

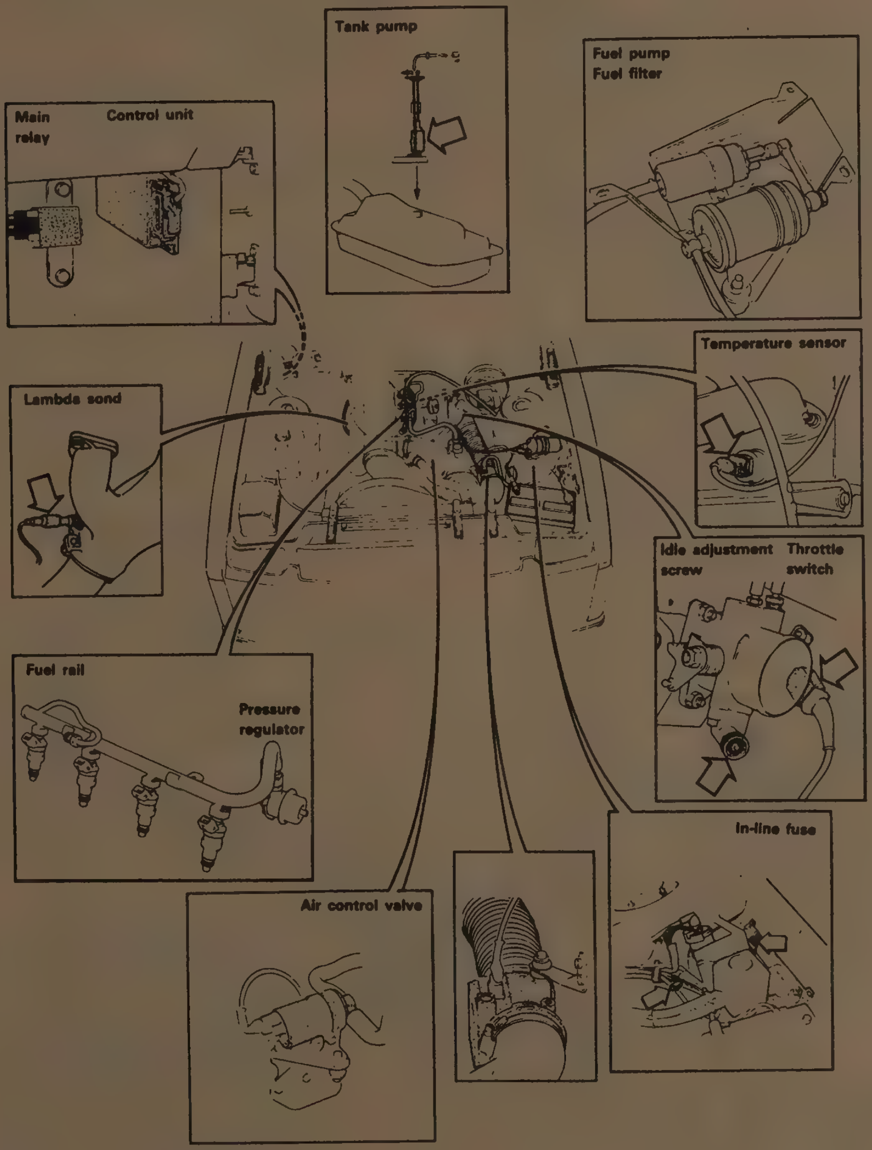

Tank pump
Fuel pump
Fuel filter
Main relay
Control unit
Temperature sensor
Lambda sond
Idle adjustment screw
Throttle switch
Fuel rail
Pressure regulator
In-line fuse
Air control valve
87865047

Fig. 52 Location of LH-Jetronic 2.2 components — B230F engines

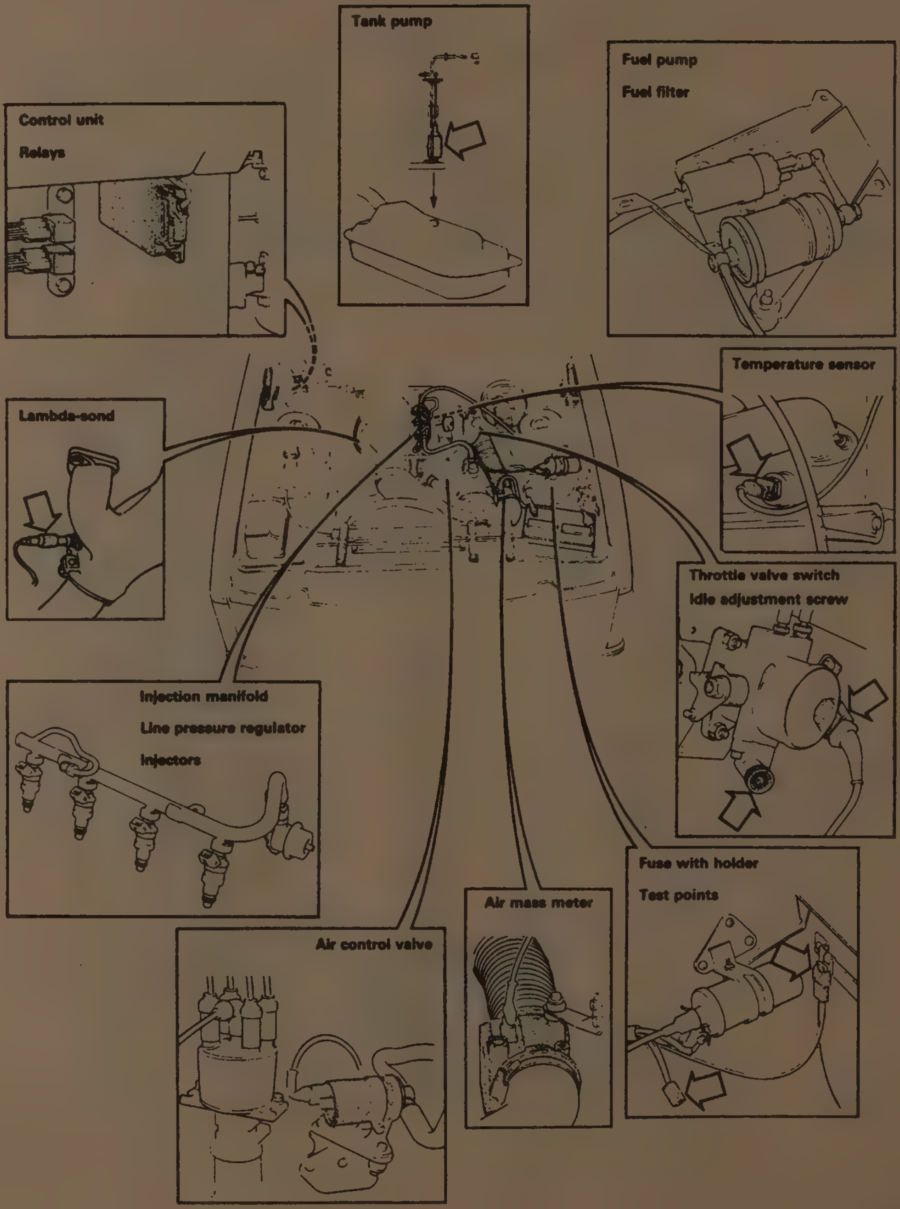

Tank pump
Fuel pump
Fuel filter
Control unit
Relays
Temperature sensor
Lambda-sond
Throttle valve switch
Idle adjustment screw
Injection manifold
Line pressure regulator
Injectors
Fuse with holder
Test points
Air mass meter
Air control valve
87865048

Fig. 53 Location of LH-Jetronic II components — B23F engines

Coolant Temperature Sensor

➧ See Figure 54

Connect the ohmmeter between ground and terminal 2. Resistance depends on coolant temperature (see chart). As a reference, if the coolant is at 68°F (20°C), look for readings of 2300-2700 ohms. If the coolant is at 176°F (80°C), expect readings of 300-360 ohms. Hint: if the ohm reading is incorrect, perform the test again at the pins of the sensor. If the readings are now correct, you have a wiring problem, not a sensor problem.

Throttle Switch (Throttle Valve Switch)

➡The terminals should be numbered on the unit in order to allow this test to be performed. If they are not, you will need to acquire a schematic or diagram of this component before testing can begin.

With the ohmmeter connected between ground and terminal 3, depress the accelerator pedal. The meter should show zero resistance in the idle position and infinite (open) in all other positions. Now connect the ohmmeter between ground and terminal 12. Again depress the accelerator pedal; look for zero resistance at full throttle and infinite at all other positions.

Double check any faulty readings at the switch on the intake manifold. If the the values are still wrong, adjust the switch or linkage or replace the switch.

Air Mass Meter: Current Supply and Ground

➧ See Figure 55

Connect a jumper from terminal 21 to ground and leave in place. On Jetronic 2.2 systems, also jumper connector 17 to ground. Under the hood, gently peel back the rubber cover on the connector to the air mass meter.

On Jetronic II systems, connect the voltmeter between terminal 9 and ground, then between 9 and 36. In both cases the meter should show battery voltage.

For Jetronic 2.2 systems, check between terminals 1 and 5 on the air mass meter, looking for battery voltage. Reinstall the protective rubber boot and remove the ground jumper(s) from the harness.

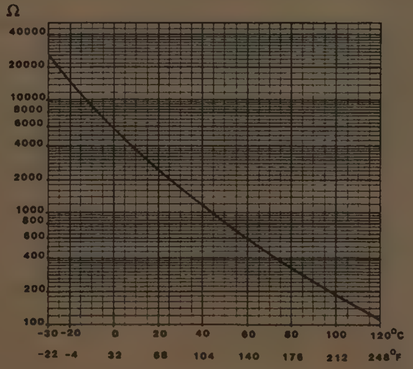


Fig. 54 Coolant temperature sensor resistance varies with coolant temperature — B230F with LH-Jetronic 2.2 shown. Others with LH-Jetronic are similar within plus or minus 100 ohms

Now use the ohmmeter to check the resistance of the wire in the air mass sensor. For both types of systems, connect the probes to terminals 6 and 7 of the ECU harness (inside the car). Correct resistance is 3.7 ohms. Test the resistance between terminals 6 and 14. Expect a reading between 0 and 1000 ohms, depending on the CO setting established at the factory.

Air Mass Meter Burn-Off Current

➡The terminals should be numbered on the unit in order to allow this test to be performed. If they are not, you will need to acquire a schematic or diagram of this component before testing can begin.

➡This test is performed with the ECU harness connected.

Start the engine and allow it to warm up fully. Shut the engine off and peel back the rubber boot at the air mass meter connector. On Jetronic II systems, connect the voltmeter between terminals 8 and 36. Restart the motor and accelerate it to at least 2000 rpm. Switch the motor off and observe the voltmeter. After about 5 seconds, the meter should show about 1 volt for about 1 second. This shows that the burn-off cycle has started and finished. Remove the voltmeter and replace the connector boot.

For Jetronic 2.2 systems, connect the voltmeter between terminals 1 and 4. Accelerate the engine above 2100 rpm and then shut it off. After 4 seconds, the meter should deflect for one second. Remove the voltmeter and replace the connector boot.

Fuel Injectors

➧ See Figures 56, 57, 58 and 59

A quick way to check injectors is simply to listen to them. With the engine running, touch a long shaft (such as a screwdriver) to the injector and listen to the opposite end. You should hear a distinct repeated clicking as the injector opens and closes. If one doesn't click, swap it with a known good one elsewhere in the system and reconnect the wires (don't get the wires interchanged). Listen again; if the bad one is still bad, replace it. If the known good one is now bad (and the

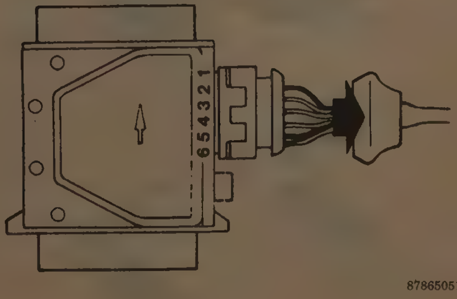


Fig. 55 Carefully remove the boot to test the circuits at the air mass meter

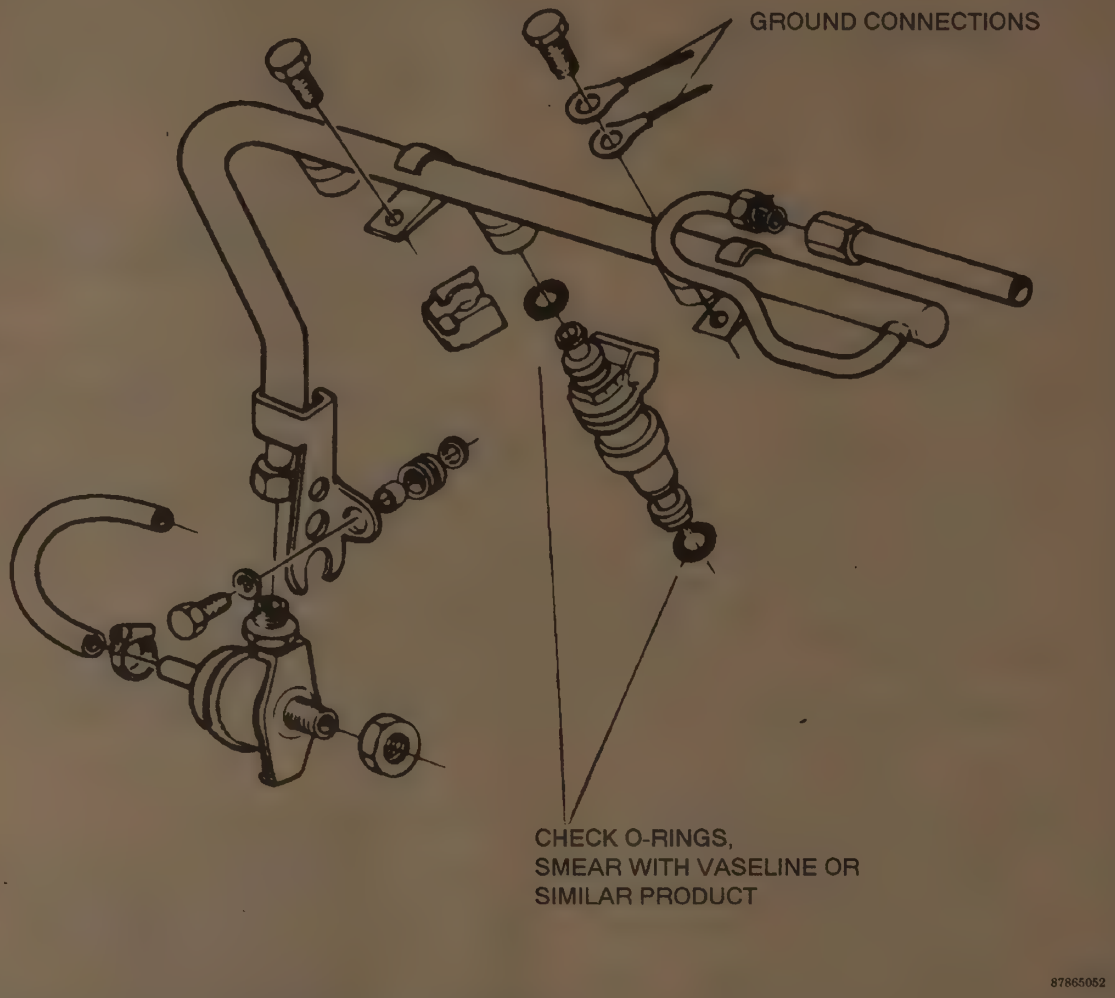

GROUND CONNECTIONS
CHECK O-RINGS,
SMEAR WITH VASELINE OR
SIMILAR PRODUCT
87865052

Fig. 56 Exploded view of the fuel injector rail — B230F engines

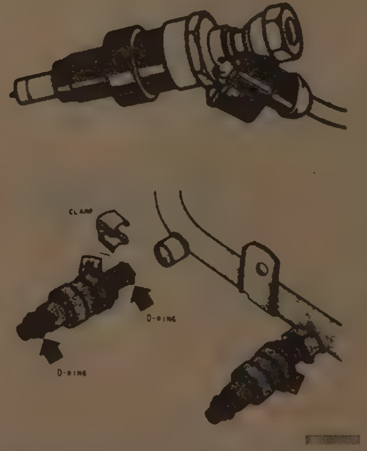

CLAMP
O-RING
O-RING

Fig. 57 1983 LH-Jetronic injector installation with clamp

first bad one now works), there is an electrical fault in the circuit to the injector.

Using an ohmmeter, you can check the injector resistance with the engine off. Disconnect the electrical lead to the injector and touch the leads to the two terminals. If the injector temperature is 68°F (20°C), resistance will be 16 ohms. Resistance will rise with injector temperature; its best to do this test on an engine which has not been run in several hours.

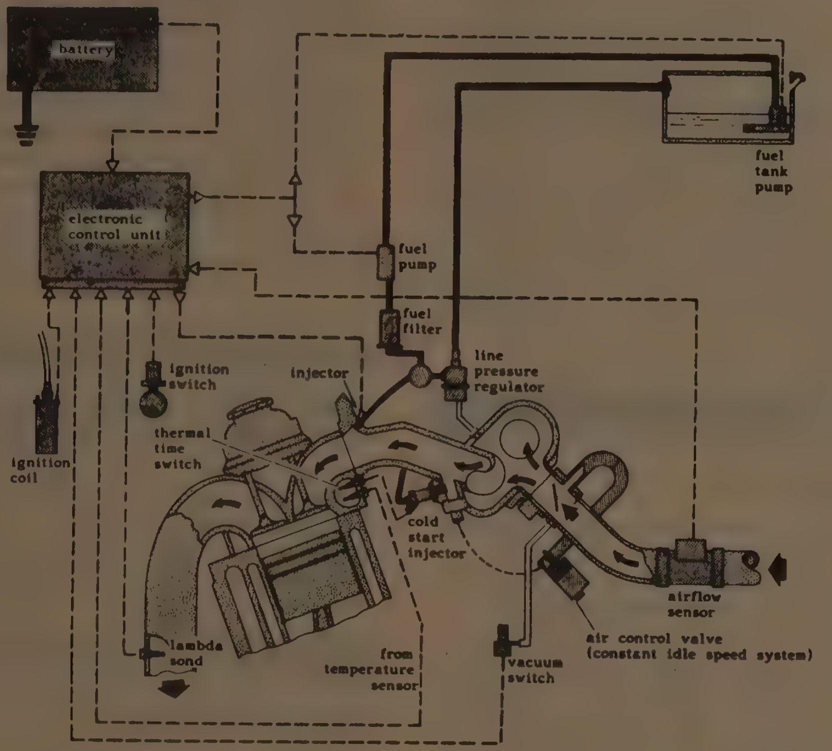

battery
electronic control unit
fuel pump
fuel filter
line pressure regulator
fuel tank pump
ignition switch
injector
thermal time switch
ignition coil
cold start injector
airflow sensor
air control valve (constant idle speed system)
lambda sond
from temperature sensor
vacuum switch

Fig. 58 LH-Jetronic fuel and electrical flow diagram

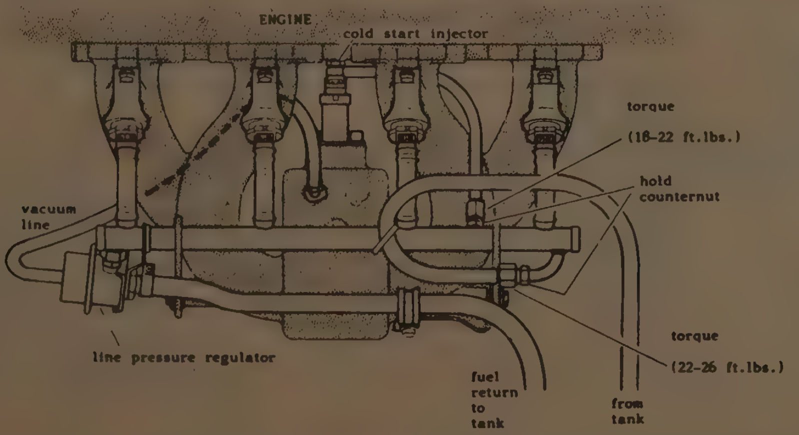

ENGINE
cold start injector
torque
(18–22 ft.lbs.)
hold counternut
vacuum line
line pressure regulator
torque
(22–26 ft.lbs.)
fuel return to tank
from tank

Fig. 59 LH-Jetronic injection manifold — 1982 and later B21 and B23F-LH models

DIESEL FUEL SYSTEMS

The Volvo diesel engine has indirect fuel injection, which means that the fuel is not injected directly into the combustion chamber but rather is fed into a small pre-combustion chamber in the head. During the compression stroke, air is forced up into the swirl chamber which is connected to the combustion chamber by a narrow channel in the head. The shape of the swirl chamber causes the air to rotate rapidly. This air speed in the swirl chamber promotes even combustion and is the reason the engine can reach fairly high engine speeds.

Fuel is injected into the swirl chamber just before the piston reaches top dead center and the fuel mixes with the turbulent air for a momentarily. As the piston reaches TDC, it compresses the air/fuel mixture to a ratio of 23:1. This ratio is over twice that of a gasoline engine. The mere act of compressing air to this level generates tremendous heat (1700°F/927°C), and it is this heat which ignites the air/fuel mixture.

Injection Lines

REMOVAL & INSTALLATION

See Figure 60

If a fuel line under the hood should become damaged or leaky, do not attempt to weld or repair it. Replacement is required in all situations. Before disassembling any of the lines, mark the location of the plastic or metal clamps which bridge the lines. These clamps are important in suppressing vibration which may loosen or damage the lines. Clamps must be reinstalled in the exact positions from which they were removed.

1. Clean all the connections carefully. Remove the vacuum pump, place it to the side and remove the plunger from the cylinder head.
2. Mark the position of all the line clamps, and disconnect ALL the fuel delivery pipes, even if you're only changing one.
3. Remove the clamp(s) holding the pipe(s) to be replaced. Install the new one, but do not tighten the fittings at this point.
4. Reinstall the clamps in their original positions. When the clamps are secure, tighten the pipe fittings to 18 ft. lbs. (24 Nm).
5. Making sure that the number one cylinder is on TDC-injection, (the flywheel notch is at the zero mark and the lobes on the camshaft for No. 1 cylinder point upward at equally large angles — you can check the camshaft lobes by looking in through the oil filler hole in the valve cover), reinstall the pump plunger and the vacuum pump.
6. Start the engine and check for leaks. The fuel system will bleed itself of air, but a few seconds will be required until the engine runs smoothly.

Diesel Fuel Injectors

Diesel fuel injectors are prone to plugging due to dirt or water in the system. Because diesel fuel is less refined than gasoline, there is a greater chance of pollutants getting into the fuel system. An inoperative injector can cause very poor fuel mileage, heavier than normal exhaust soot, uneven idle, loss of power and/or overheating and knocking in the cylinder. Don't mistake normal bearing clatter — a generalized noise throughout the engine — for a knocking in a specific cylinder.

REMOVAL & INSTALLATION

See Figures 61 and 62

To perform a quick check on the injectors, run the engine at above idle speed. Wrap an absorbent rag around the pipe joint at the injector and loosen the cap nut on the injector. As the pressure in the line leaks off, the cylinder should cease firing and the engine characteristics should change.

If there is no change in engine behavior, the injector or its heat shield may be defective. Injectors cannot be repaired or

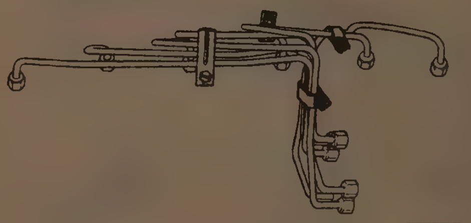


Fig. 60 Make sure all clamps are properly in place to prevent excessively harsh vibration to the lines

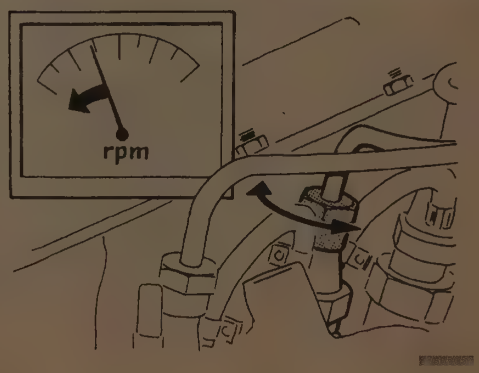


Fig. 61 To quickly check an injector, loosen the injector and determine whether engine rpm decreases

disassembled; defective injectors must be replaced. If removing or replacing an injector is necessary:

1. Clean all the connections thoroughly before disconnecting anything.
2. Disconnect the fuel delivery pipe(s) at the affected injector(s) and plug the open ends to keep out dirt and dust.
3. Use a 27mm socket and carefully remove the injector from the cylinder head. Remove the heat shield which sits under the injector; it looks like a small, dished washer.
4. Remove any soot or dirt from the sealing surfaces.
5. Install new heat shields for each injector removed. Make sure they are installed with the dished side up. An upside-down heat shield will cause symptoms identical to a failed injector.
6. Install the new injector(s) and tighten to 50 ft. lbs. (68 Nm). Reconnect the delivery pipes and tighten the connections to 18 ft. lbs. (24 Nm).
7. Start the engine and check for leaks.

There is no way to test diesel injectors without an elaborate test bench. Your dealer may have this test equipment.

****CAUTION**

Do not attempt to test the injector by connecting it to its fuel line while out of the engine. You will damage the line by bending it and you run the risk of injury. The injector is under enough pressure that the atomized fuel can penetrate your flesh, inducing blood poisoning.

Fuel Pump/Injection Pump

The fuel pump is also the injection pump and is located on the left rear side of the engine, driven by a belt running off the rear of the camshaft. The pump supplies the engine with more fuel than it can use, the excess fuel being returned to the fuel tank through suction/return lines. The system constantly bleeds itself of air. Because the pump moves such large amounts of fuel, it tends to stay cool and this reduces the chances of vapor lock. The pump is lubricated by the fuel passing through it. Do not use fuel additives unless specifically recommended by Volvo for fear of damaging the pump.

The pump contains a single piston which rotates and distributes fuel to each injector in the correct sequence, much in the same way the distributor on a gasoline engine distributes the spark to the spark plugs.

REMOVAL & INSTALLATION

See Figure 63

****WARNING**

The use of the correct special tools or their equivalent is REQUIRED for this procedure. Several special tools are needed to remove and install the pump and to set its timing. If these tools are not available, do not attempt to remove the pump. The Volvo tool numbers are given in the procedure.

1. Pinch off and remove the two coolant hoses running to the cold start device on the fuel pump.
2. Disconnect the accelerator linkage at the pump and disconnect the wire from the stop valve on the top of the pump. Disconnect the hose coming from the intake manifold.
3. Remove the rear timing belt cover and thoroughly clean the fuel lines and their connections at the injection pump.
4. Disconnect the fuel lines at the pump and plug the open connections to prevent dirt from entering the fuel system.
5. Remove the vacuum pump and its plunger.
6. Clean and remove the delivery lines at the fuel injectors. Plug all connections. Remove the lines as a unit and set them aside.
7. Set cylinder No. 1 to TDC injection stroke. At this position, the 0 mark on the flywheel aligns with the pointer and the notch on the injection pump pulley aligns with the notch on the pump housing. Both valves on No. 1 cylinder are closed and their camshaft lobes are pointing up at equally large angles.
8. Loosen the retaining bolts for the injection pump, push the pump up, and remove the pump drive belt. Tighten one bolt to hold the pump in the upper position.

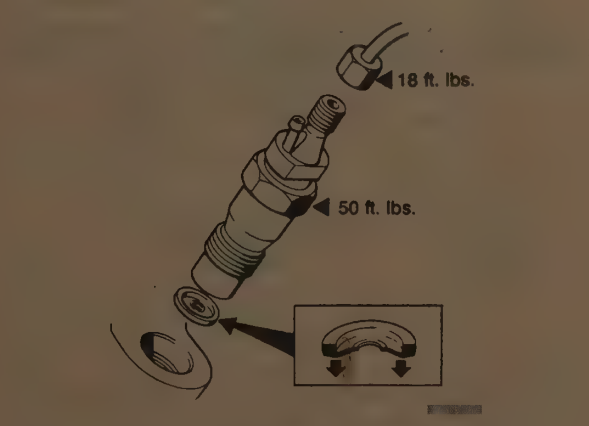


Fig. 62 Exploded view of diesel fuel injector mounting — observe proper torque values when installing

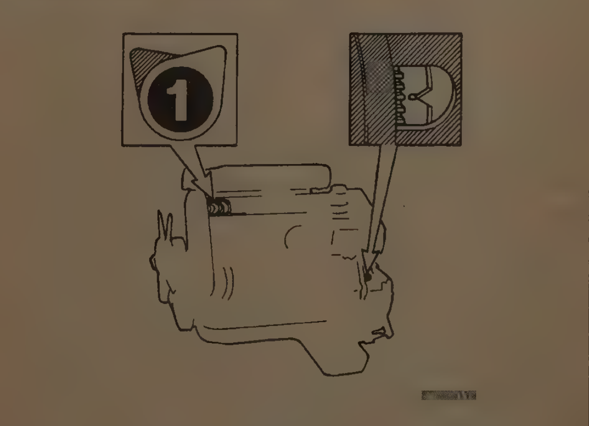


Fig. 63 Set the No. 1 cylinder to TDC for the injection stroke — the cam lobes are visible through the oil filler cap and will appear as shown

9. Loosen the center bolt in the rear camshaft gear while using wrench 5199 to hold the gear. The bolts will be easily accessible if wrench 5201 is used.

➡The camshaft must not rotate. Loosen the bolt only enough to rotate the gear on the camshaft.

10. Insert locking pin (No. 5193) into the injection pump gear to lock it in position. Remove the injection pump gear nut and washer.
11. With the pin still in position, use a puller to remove the pump gear.
12. Remove the bolts retaining the front injection pump bracket to the engine, then remove the bolts retaining the pump and remove the pump from the engine.
13. Install the pump on the engine and tighten the bolts only finger tight so that pump position can be adjusted.
14. Set the injection pump so that the mark on pump and the pump bracket align, then tighten the retaining bolts.
15. Make sure the shaft key is correctly installed and install the injection pump gear, washer and nut. Use pin 5193 to hold the gear while tightening the nut.
16. Proceed to Setting the Injection Pump Timing, below.
17. After the injection pump timing is set, fill the pump with clean diesel fuel through the fuel line connection. Make sure you filter the fuel before pouring it into the pump.
18. Install the rear timing gear cover. Connect the fuel lines and fuel delivery pipes. Tighten the fuel line cap nuts and the fuel line banjo bolts to 18 ft. lbs. (24 Nm).When installing the fuel lines on the pump, do not mix the banjo bolts: the bolt for the fuel return line has a small hole in it and is marked OUT.
19. Install the vacuum pump and all remaining components. Adjust the accelerator linkage.

SETTING INJECTION PUMP TIMING

➧ See Figures 64, 65, 66 and 67

✲✲WARNING

The use of the correct special tools or their equivalent is REQUIRED for this procedure.

1. Set cylinder No. 1 to TDC injection stroke. At this position, the 0 mark on the flywheel aligns with the pointer and the notch on the injection pump pulley aligns with the notch on the pump housing. Both valves on No. 1 cylinder are closed and their camshaft lobes are pointing up at equally large angles.
2. Disconnect the cold start device on the injection pump by loosening screw No. 1 in the illustration, pushing the lever forward and rotating the sleeve 90°. Push the lever back against the stop. Do not touch screw No. 2 in the illustration or the cold start device will have to be reset on a test bench.
3. Loosen the injection pump retaining screws and turn the pump so that the markings on the injection pump and the pump bracket align. Install the lock pin (No. 5193) in the injection pump gear to lock the gear in position. Any pin can be used to lock the gear, however there cannot be any movement of the gear when the pin is installed.
4. Remove the plug in the injection pump distributor and install special holder 5194 and a dial indicator gauge with a measuring range of 0-0.12 in. (0-3mm.) Set the dial gauge at approximately 0.08 in. (2mm).
5. Remove the stop pin and turn the injection pump (using its gear) in its normal direction of rotation until the marks on the injection pump gear and the bracket align.
6. Turn the injection pump gear slightly counterclockwise until the dial gauge indicates its lowest reading. In this position set the dial gauge to zero. Turn the injection pump gear clockwise until the marks on the gear and the bracket align again, then refit the lock pin to lock the gear in position.
7. Install the rear camshaft gear (if removed) and tighten its center bolt only hand tight. Install the drive belt.
8. Adjust the drive belt to the proper tension by moving the pump on its mounts. If you're using the Volvo tension gauge (5197), set the tension gauge to 12.5 and apply tension to the belt until the mark on the plunger of the gauge is flush with

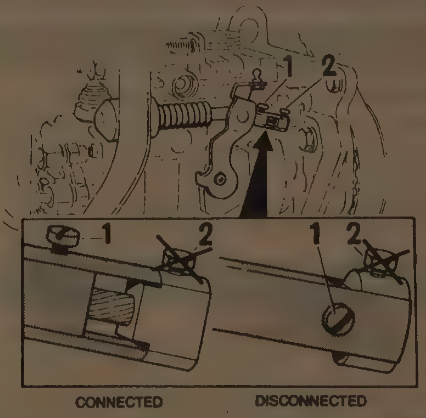


Fig. 64 Loosen screw No. 1 to disconnect the cold start device, but do not loosen screw No. 2

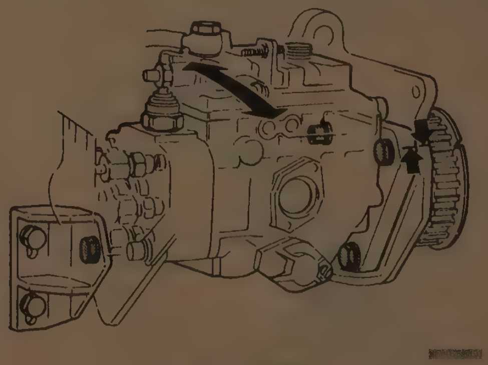


Fig. 65 Loosen the injection pump retaining screws and turn the pump so the markings align

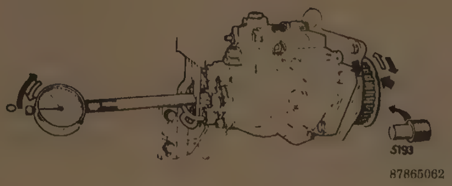


Fig. 66 With the dial gauge properly installed, turn the pump and align the marks

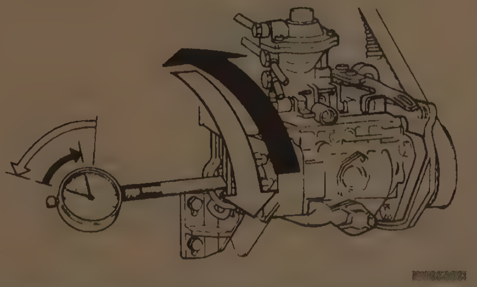


Fig. 67 Relationship between the pump motion and dial indicator reading when setting the diesel injection pump timing

the gauge sleeve. Depress the belt heavily with your hand then recheck and adjust the tension.

**WARNING

The dial indicator readings given in the text below are for 1979-1981 US and Canada D24 engines. Specifications for other engines are given at the end of the section.

9. Use wrench 5199 (or a suitable substitute) to hold the rear camshaft gear in place and install wrench 5201 with a torque wrench attached on the center bolt. The torque wrench should be installed at a 90° angle to wrench 5201 to give correct readings. Use wrench 5199 or its substitute to turn the camshaft gear until the dial gauge in the injection pump reads 0.028 in. (0.70mm). Hold the gear in this position and tighten the center bolt to 73 ft. lbs. (99 Nm) without moving either the camshaft or the gear.
10. Remove the lock pin and turn the engine over two full turns (one complete four stroke cycle) until the No. 1 cylinder is again on TDC compression stroke. Check the reading on the dial indicator gauge. It should read 0.028 in (0.70mm). If the reading is correct, proceed to Step 13.
11. If the reading is less than 0.028 in. (0.70mm), loosen the injection pump retaining screws and turn the pump inward until a reading of 0.028 in. (0.70mm) is obtained. Repeat Step 10.
12. If the reading is more than 0.028 in. (0.70mm), loosen the injection pump retaining screws and turn the pump outward until the reading on the gauge is approximately 0.024 in. (0.60mm). Next, turn the pump inward to obtain a reading of 0.028 in (0.70mm) and tighten the retaining bolts. Repeat Step 10.

➡When adjusting, do not tap or knock the pump as this will alter the settings.

13. Remove the dial indicator and its holder and install the plug. Tighten the plug to 6.5 ft. lbs. (9 Nm).
14. Attach the cold start device. Reverse Step 1, above. Install all remaining components.

The following are injection pump timing specifications in millimeters of dial indicator reading:

- D20: 0.80
- D24: 0.85
- 1982-83 D24T: 0.80
- 1984-85 D24T: 0.85, Exc. Calif.
- 1984-85 D24T: 0.75 Calif.

Glow plugs (Preheating System)

The preheating system warms the swirl chambers prior to engine start-up. The length of time the plugs are on is determined by the coolant temperature. A coolant temperature sensor sends this data to a control unit which regulates the engagement time of the glow plugs.

When the ignition key is in the **ON** position, the system is engaged and the dashboard light comes on. After the dash indicator goes out, the plugs remain on for 1-14 seconds, depending on conditions. When the engine starts, the glow plugs are switched off. There is a safety circuit built in which will turn the circuit off after a predetermined amount of time if the engine is not started. This prevents the glow plugs from melting and damaging the engine.

TESTING & REPLACEMENT

➡These tests must be carried out with the engine coolant below 100°F (38°C). During any of these tests, remember that the glow plug circuit will shut off after a period of time. It will be necessary to cycle the ignition switch to OFF and then back to ON to continue testing.

Since the glow plug circuitry uses the normal 12 volt electrical system of the car, it is fairly simple to test with a test light. A voltmeter can also be used.

To check for power to the glow plug, connect the test light to ground and touch the other end to the plug terminal. Turn the key to the **ON** position and look for both the test lamp and the dashboard indicator to illuminate. If both lamps light, all is well up to the glow plug. If either or both don't light, check the control relay as explained below.

Remove the test lamp and turn the key **OFF**. Disconnect and remove the ground bar which runs between the glow plugs. Connect one end of the test light to the positive (+) terminal of the battery and touch the other end to the end of one glow plug. If the test light comes on, that plug is good. If the glow plug must be replaced, do so by simply unscrewing it and installing a new one. Reconnect the ground bars between the plugs.

Glow Plug Control Unit (Relay)

See Figure 68

On cars with the D24 engine, the control unit is located under the left side of the dashboard. On Turbo models, it is found under the hood on the left shock tower. For D24T vehicles, disconnect the control unit plug and turn the ignition **ON**. Ground one end of the test light and check for voltage at terminal 15. If no voltage is present, a wiring fault is present. Also check the terminal of the orange wire. If both the dash indicator and the test light come on, the control unit is failed.

Also with the ignition **ON**, check for voltage at terminal 30 on the relay; no voltage shows a wiring fault between the battery and the control unit. Check terminal G for voltage; if no voltage is present, check the 80 amp fuse on the bottom of the relay. If voltage is present, the control unit is OK. Remove the test light and reinstall it to the positive battery terminal. Check the control unit ground by touching the test light to terminal 31 (black wire) on the control unit. If the test light does not come on, the unit is not grounded.

On the D24 family, leave the connector on the relay and check for voltage at terminal 15 (blue-with-red wire). No voltage shows a wiring fault between the fuse box and the relay. Under the hood, check the smaller glow plug relay (on the left shock tower) for voltage at terminal 86. Connect the test light to the positive battery terminal and check the glow plug relay for proper ground at terminal 31. If the test lamp lights up, the relay is bad. Remember this is all being done with the engine cold, the ignition **ON** and within the operating cycle of the glow plugs being on.

Back inside the car, check for voltage at terminal G on the control unit. No voltage indicates a faulty control unit. Connect the test light to the PLUS terminal on the fusebox (+) and check terminal K on the control unit. If the test lamp lights up, you have either a defective dashboard indicator light, a wiring problem between the control unit and the indicator light, or a fault in the printed circuit behind the instrument panel. If the test light does not come on, either the control unit is bad or the wire between the control unit and the temperature sensor is grounded when it shouldn't be.

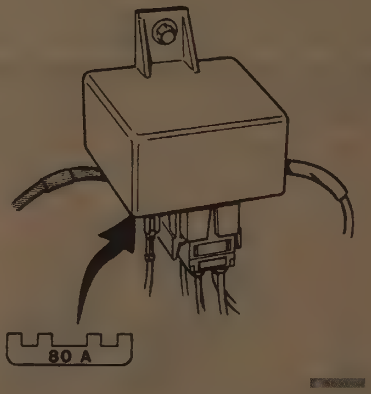


Fig. 68 Check the 80 amp glow plug fuse located on the bottom of the relay

FUEL TANK

Tank Assembly

REMOVAL & INSTALLATION

All Models (Except 760 and 780, 1988 and Later)

Generally stated, the only reason to remove the fuel tank should be in cases of physical damage or to gain access to the rear body work for repairs. The tank can be drained in the car by using the fuel pump to pump most of the fuel through the system and collecting it at a disconnected hose near the tank or under the hood. Reconnect and secure the line after draining the system. Its easier if you schedule the work to occur when the tank is nearly empty.

CAUTION

The fuel system is under pressure. Release pressure slowly and contain spillage. Observe no smoking/no open flame precautions. When performing this work, always have a dry-chemical fire extinguisher handy and know how to use it. Use clean containers large enough to collect all the fuel drained out. Keep drained fuel out of the work area and tightly covered.

For all cars except the 1988 and later 760 and 780 series, after draining the tank:

1. With the ignition key **OFF** and all electrical components (radio, heater, etc.) turned off, disconnect the negative battery cable.
2. In the trunk, remove the panels which cover the filler hose. Remove or roll back the trunk carpet or liner and remove the screws holding the access panel in the floor of the trunk.
3. Label and disconnect the filler, overflow and fuel return lines at the tank. It may be necessary to loosen or disconnect some lines at the filler neck as well.
4. Disengage wiring connectors and grounding connections, labeling as necessary.
5. Block the front wheels, jack the rear end and support the rear of the car with jackstands.
6. Under the car, clamp off and disconnect the hoses between the tank and the body lines. Depending on the model, there may be a mass of hoses around the fuel pump and accumulator. Since some of these components may be bolted to the tank (and be removed with it) look for the fuel lines

coming from the body. Identify and disconnect as few lines as possible to make reconnection easier. Label everything.

7. Double check all four sides of the tank and the top surface. There should be no wires or hoses connecting the tank to the car. Check the security of all the plugs or clamps in the fuel lines.

8. Position the jack under center of the tank and use a broad, flat piece of wood between the jack and the bottom of the tank. Raise the jack until it just contacts the tank.

9. Depending on your model, it may be necessary to remove various heat shields or protective covers from the side of the tank or the body. Loosen and remove the tank retaining bolts. The jack should have enough elevation to support the tank in position until all the bolts are removed.

10. With the tank completely free and supported only by the jack, lower the jack about two inches and hold that position. Perform a final check for any line or wire still connected and check for possible points of interference in the downward path of the tank.

11. Balance the tank with one hand and slowly release the jack to lower the tank clear of the car. When the tank is clear of the car, the fuel sender and in-tank fuel pump (if so equipped) can be removed by unscrewing the locking ring on the top of the tank. Drain the remaining fuel immediately and store it safely. Remember that fuel vapors (fumes) are highly explosive — get the tank dry as soon as possible and keep it out of enclosed areas where fumes could be trapped.

12. When reinstalling the tank, make sure that the fuel sender and auxiliary pump is properly seated in its mounts and is not resting or binding on anything inside the tank. Make sure that any of the foam rubber insulators on the outside of the tank have not come off. Position the tank on the board and jack as before and elevate it into position. Install the mounts and/or retaining bolts to hold the tank to the car. Remove the jack from the tank area.

13. Reinstall any heat shields or covers which were removed for access.

14. Under the car, remove the plugs from each fuel line and connect it to the proper port on the tank or fuel system. Make sure you get things in the correct place or the car won't run. Make sure each connection is clean and tight, with the proper hose clamps as necessary. Double check for any kinks or points of interference.

15. Using the jack, remove the jackstands and lower the car to the ground. In the trunk, connect the filler, delivery and overflow hoses to the tank. Insure clean tight connections, using new clamps if necessary. If the larger hoses are difficult to fit onto the ports, a light coating of spray silicone inside the hose will ease the job.

16. Reconnect the wiring terminals to the top of the sender unit. Check that the connectors are not corroded or loose. If there is a tank-to-body ground wire, check the body connection for poor contact and/or corrosion and repair if necessary.

17. Check and secure any loosened connections at the fuel filler neck in the fender area. Double check all installation items, paying particular attention to loose hoses or hanging wires, untightened nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the area. Replace the trunk floor access panel, the trunk floor mat or carpet and install the cover panel over the filler hose.

18. Remove the gas cap and safely deliver clean, fresh fuel into the tank. Use a funnel and pour from a closed container. If you value your paint, don't spill fuel down the bodywork of the car. Replace the gas cap.

19. Reconnect the negative battery cable.

20. Turn the ignition key to the **ON** position for five seconds. Cycle it to **OFF** and back to **ON** for another 5 seconds. Turn it **OFF** and then start the engine. Although the two **ON** cycles partially primed the system, the engine may crank longer than normal until the correct pressures are developed and fuel reaches the engine.

21. After the engine has started and is running smoothly, shut it off and recheck every hose connection for any sign of leakage or seepage. Remember that the system is once again holding pressure. Be very careful when working around lines and fittings.

760 and 780 Models, 1988 and Later

➧ See Figures 69, 70, 71 and 72

These cars have a saddle type tank designed to fit around the revised rear axle design. The tank is constructed of heavy-duty plastic. The driveshaft runs through a tunnel in the tank and must be removed during tank removal. The tank has several heat shields and safety shields to guard it against damage from heat or driveshaft contact.

⁂CAUTION

The fuel system is under pressure. Release pressure slowly and contain spillage. Observe no smoking/no open flame precautions. When performing this work, always have a dry-chemical fire extinguisher handy and know how to use it. Use clean containers large enough to collect all the fuel drained out. Keep drained fuel out of the work area and tightly covered.

1. Because of a higher degree of sophisticated electronic components, all electrical components (radio, heater fan, etc) must be turned off as well as the ignition switch. Disconnect the negative battery cable. The electrical "spike" caused by this disconnection can destroy components in micro-processing units.

2. In the trunk, disconnect the left side drain hose. Remove the spare tire cover and the trunk mat. Remove the panel and cover for the fuel filler pipe.

3. Remove the access panel over the fuel level sender. Disconnect the fuel hoses at the sender and the wire connectors in the trunk. Press the rubber grommet out of the bodywork and remove the wire through the hole.

4. Using a small pump and lengths of hose, drain the tank by sucking fuel out through the filler pipe hole in the fuel sender assembly. This is the only way to drain the tank. Removing the tank with fuel in it is NOT recommended. The added weight of the fuel (approximately 7.2 pounds per gallon/0.85 kg per liter) will imbalance the tank and damage the mounts during removal.

5. Block the front wheels, jack the rear end and support the rear of the car with jackstands.

6. From under the car, remove the three bolts holding the heat shield at the front of the tank and remove the shield.

7. Disconnect the front tank attachment by removing the two strap bolts. The outer bolts should be loosened about $^3/_8$ inch but not removed. This will allow you to pull the straps out of the front attachment.

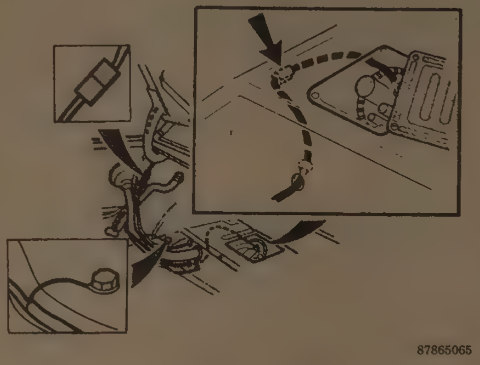


Fig. 69 Unplug the fuel tank electrical connectors — location for 760 and 780 models

8. Remove the bracket under the tank and remove the nut for tank attachment point on the right side.

9. Gently pull the tank loose from the body. Let the tank rest on the front attachment. The tank is still retained at the rear and cannot come free of the car yet.

10. Mark the front and rear driveshaft (propeller shaft) so that they may be reassembled correctly. Remove the rear flange bolts. Slide the rear driveshaft loose from the splines at the front support bearing.

11. Position a jack under center of the tank and use a broad, flat piece of wood between the jack and the bottom of the tank. Raise the jack until it just contacts the tank.

12. Remove the front tank attachment. Lower the tank slightly and pull it forward. On the top of the tank, remove the hose from the expansion tank port. Remove the tank from the car and remove the shield panels from the tank.

13. Unscrew the locking ring and remove the fuel sender assembly from the tank. Be careful of the wiring harness attached to the top. Remember that fuel vapors (fumes) are highly explosive — get the tank dry as soon as possible and keep it out of enclosed areas where fumes could be trapped.

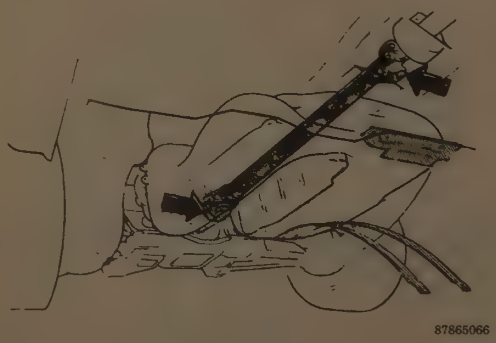


Fig. 70 Disconnect the rear driveshaft at the points indicated by the arrows — 1988-89 760 and 780 models

14. When reinstalling the tank, secure the shield panels to the tank first. Install the fuel sender assembly, making sure it seats properly and is not damaged by hitting the baffles inside the tank during installation. The small arrows on the housing should align with the seam in the top of the tank. Position the wire harness around the tank hose connections.

15. Check that the foam insulator pads on the tank are in place and not crushed. Replace any as needed.

16. Loosen but do not remove the bolts in the rear strap mount. Using the jack and the board, position the tank into the car and fit it into the rear mount.

17. Reconnect the hose to the expansion port on the top of the tank and secure the clamp. Observe the placement of the right side tank mount and move the tank into its final position. Tighten the rear clamp bolts.

18. Install the front tank attachment and tighten the two outer bolts just a few turns. The tank is now resting in its mounts, lower at the front. Remove the jack from the area.

19. Install the drive shaft, observing the matchmarks made earlier. Replace and tighten the rear flange bolts.

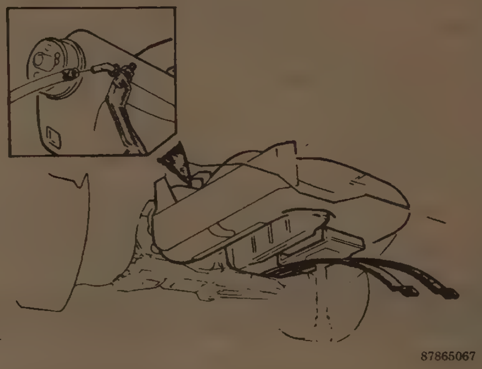


Fig. 71 On 1988-89 760 and 780 models, don't forget the evaporative hose above the tank

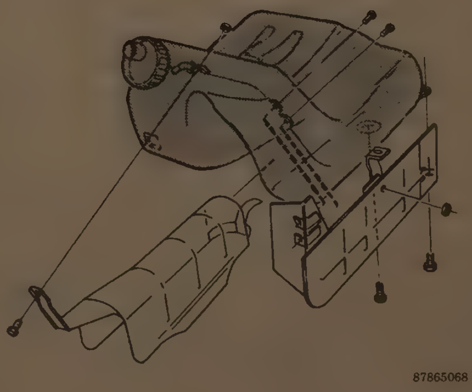


Fig. 72 Be sure to reinstall the safety shields

20. Install the straps to the front mount, tighten the outer two bolts and then tighten the strap retaining bolts. Reinstall the heat shield over the front tank mount.

21. Reinstall the right side mount and the under-tank bracket.

22. Using the jack, remove the jackstands and lower the car to the ground.

23. Route the harness through the bodywork and into the trunk. Attach the wire to the clip on the sidemember under the trunk. Install the bolt for the ground connector and reconnect the harness and ground.

24. Reconnect the hoses to the tank sender unit, making sure all connections are clean and tight.

25. Remove the gas cap and safely deliver clean, fresh fuel into the tank. Use a funnel and pour from a closed container. If you value your paint, don't spill fuel down the bodywork of the car. Replace the gas cap.

26. Reconnect the negative battery cable.

27. Turn the ignition to the **ON** position. Listen for the fuel pump running and check for any system leaks. Check that the fuel gauge on the dash is registering properly. Remembering that the system has repressurized itself, attend to leaks or loose connectors.

28. In the trunk, replace the access panel over the fuel sender. Connect the drain hose on the left side and install the protective covers and panel to conceal the fuel filler hoses. Replace the spare tire cover and install the trunk mat.

Troubleshooting Basic Fuel System Problems

Problem	Cause	Solution
Engine cranks, but won't start (or is hard to start) when cold	• Empty fuel tank • Incorrect starting procedure • Defective fuel pump • No fuel in carburetor • Clogged fuel filter • Engine flooded • Defective choke	• Check for fuel in tank • Follow correct procedure • Check pump output • Check for fuel in the carburetor • Replace fuel filter • Wait 15 minutes; try again • Check choke plate
Engine cranks, but is hard to start (or does not start) when hot—(presence of fuel is assumed)	• Defective choke	• Check choke plate
Rough idle or engine runs rough	• Dirt or moisture in fuel • Clogged air filter • Faulty fuel pump	• Replace fuel filter • Replace air filter • Check fuel pump output
Engine stalls or hesitates on acceleration	• Dirt or moisture in the fuel • Dirty carburetor • Defective fuel pump • Incorrect float level, defective accelerator pump	• Replace fuel filter • Clean the carburetor • Check fuel pump output • Check carburetor
Poor gas mileage	• Clogged air filter • Dirty carburetor • Defective choke, faulty carburetor adjustment	• Replace air filter • Clean carburetor • Check carburetor
Engine is flooded (won't start accompanied by smell of raw fuel)	• Improperly adjusted choke or carburetor	• Wait 15 minutes and try again, without pumping gas pedal • If it won't start, check carburetor

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CIS Troubleshooting

Symptom	Possible Reasons
Idle varies up and down, more than ±50 rpm for 1981 models, more than ±20 rpm for 1982 and later models.	–CO adjustment incorrect. –Ignition timing incorrect. –Throttle butterfly valve incorrectly adjusted. –Electronic Control Unit faulty. –Air control valve faulty.
Idle speed too high.	–Air control valve sticks. –Bad contact in connector. –Throttle switch incorrectly adjusted. –Temperature sensor faulty or not connected.
No speed control.	–Air control valve sticks. –Bad contact in connector. –Throttle switch incorrectly adjusted. –Electronic Control Unit faulty. –Air control valve faulty.
Engine stalls when braking to stop.	–CO adjustment incorrect. –Ignition timing incorrect. –Throttle butterfly valve incorrectly adjusted. –Bad contact in connector. –Electronic Control Unit faulty. –Low basic rpm.
No rapid idle speed when cold.	–Air control valve sticks. –Electronic Control Unit faulty. –Air control valve faulty. –Coolant temperature sensor faulty.

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6

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UNDERSTANDING AND TROUBLESHOOTING ELECTRICAL SYSTEMS

Over the years import and domestic manufacturers have incorporated electronic control systems into their production lines. In fact, electronic control systems are so prevalent that all new cars and trucks built today are equipped with at least one on-board computer. These electronic components (with no moving parts) should theoretically last the life of the vehicle, provided that nothing external happens to damage the circuits or memory chips.

While it is true that electronic components should never wear out, in the real world malfunctions do occur. It is also true that any computer-based system is extremely sensitive to electrical voltages and cannot tolerate careless or haphazard testing/service procedures. An inexperienced individual can literally cause major damage looking for a minor problem by using the wrong kind of test equipment or connecting test leads/connectors with the ignition switch **ON**. When selecting test equipment, make sure the manufacturer's instructions state that the tester is compatible with whatever type of system is being serviced. Read all instructions carefully and double check all test points before installing probes or making any test connections.

The following section outlines basic diagnosis techniques for dealing with automotive electrical systems. Along with a general explanation of the various types of test equipment available to aid in servicing modern automotive systems, basic repair techniques for wiring harnesses and connectors are also given. Read the basic information before attempting any repairs or testing. This will provide the background of information necessary to avoid the most common and obvious mistakes that can cost both time and money. Although the replacement and testing procedures are simple in themselves, the systems are not, and unless one has a thorough understanding of all components and their function within a particular system, the logical test sequence these systems demand cannot be followed. Minor malfunctions can make a big difference, so it is important to know how each component affects the operation of the overall system in order to find the ultimate cause of a problem without replacing good components unnecessarily. It is not enough to use the correct test equipment; the test equipment must be used correctly.

Safety Precautions

****CAUTION**

Whenever working on or around any electrical or electronic systems, always observe these general precautions to prevent the possibility of personal injury or damage to electronic components.

- Never install or remove battery cables with the key **ON** or the engine running. Jumper cables should be connected with the key **OFF** to avoid power surges that can damage electronic control units. Engines equipped with computer controlled systems should avoid both giving and getting jump starts due to the possibility of serious damage to components from arcing in the engine compartment if connections are made with the ignition **ON**.
- Always remove the battery cables before charging the battery. Never use a high output charger on an installed battery or attempt to use any type of "hot shot" (24 volt) starting aid.
- Exercise care when inserting test probes into connectors to insure good contact without damaging the connector or spreading the pins. Always probe connectors from the rear (wire) side, NOT the pin side, to avoid accidental shorting of terminals during test procedures.
- Never remove or attach wiring harness connectors with the ignition switch **ON**, especially to an electronic control unit.
- Do not drop any components during service procedures and never apply 12 volts directly to any component (like a solenoid or relay) unless instructed specifically to do so. Some component electrical windings are designed to safely handle only 4 or 5 volts and can be destroyed in seconds if 12 volts are applied directly to the connector.
- Remove the electronic control unit if the vehicle is to be placed in an environment where temperatures exceed approximately 176°F (80°C), such as a paint spray booth or when arc/gas welding near the control unit location.

Understanding Basic Electricity

Understanding the basic theory of electricity makes electrical troubleshooting much easier. Several gauges are used in electrical troubleshooting to see inside the circuit being tested. Without a basic understanding, it will be difficult to understand testing procedures.

THE WATER ANALOGY

Electricity is the flow of electrons — hypothetical particles thought to constitute the basic stuff of electricity. Many people have been taught electrical theory using an analogy with water. In a comparison with water flowing in a pipe, the electrons would be the water. As the flow of water can be measured, the flow of electricity can be measured. The unit of measurement is amperes, frequently abbreviated amps. An ammeter will measure the actual amount of current flowing in the circuit.

Just as the water pressure is measured in units such as pounds per square inch, electrical pressure is measured in volts. When a voltmeter's two probes are placed on two live portions of an electrical circuit with different electrical pressures, current will flow through the voltmeter and produce a reading which indicates the difference in electrical pressure between the two parts of the circuit.

While increasing the voltage in a circuit will increase the flow of current, the actual flow depends not only on voltage, but on the resistance of the circuit. The standard unit for measuring circuit resistance is an ohm, measured by an ohmmeter. The ohmmeter is somewhat similar to an ammeter, but incorporates its own source of power so that a standard voltage is always present.

CIRCUITS

An actual electric circuit consists of four basic parts. These are: the power source, such as a generator or battery; a hot wire, which conducts the electricity under a relatively high voltage to the component supplied by the circuit; the load, such as a lamp, motor, resistor or relay coil; and the ground wire, which carries the current back to the source under very low voltage. In such a circuit the bulk of the resistance exists between the point where the hot wire is connected to the load, and the point where the load is grounded. In an automobile, the vehicle's frame or body, which is made of steel, is used as a part of the ground circuit for many of the electrical devices.

Remember that, in electrical testing, the voltmeter is connected in parallel with the circuit being tested (without disconnecting any wires) and measures the difference in voltage between the locations of the two probes; that the ammeter is connected in series with the load (the circuit is separated at one point and the ammeter inserted so it becomes a part of the circuit); and the ohmmeter is self-powered, so that all the power in the circuit should be off and the portion of the circuit to be measured contacted at either end by one of the probes of the meter.

For any electrical system to operate, it must make a complete circuit. This simply means that the power flow from the battery must make a complete circle. When an electrical component is operating, power flows from the battery to the component, passes through the component causing it to perform it to function (such as lighting a light bulb) and then returns to the battery through the ground of the circuit. This ground is usually (but not always) the metal part of the vehicle on which the electrical component is mounted.

Perhaps the easiest way to visualize this is to think of connecting a light bulb with two wires attached to it to your vehicle's battery. The battery in your vehicle has two posts (negative and positive). If one of the two wires attached to the light bulb was attached to the negative post of the battery and the other wire was attached to the positive post of the battery, you would have a complete circuit. Current from the battery would flow out one post, through the wire attached to it and then to the light bulb, where it would pass through causing it to light. It would then leave the light bulb, travel through the other wire, and return to the other post of the battery.

AUTOMOTIVE CIRCUITS

The normal automotive circuit differs from this simple example in two ways. First, instead of having a return wire from the bulb to the battery, the light bulb return the current to the battery through the chassis of the vehicle. Since the negative battery cable is attached to the chassis and the chassis is made of electrically conductive metal, the chassis of the vehicle can serve as a ground wire to complete the circuit. Secondly, most automotive circuits contain switches to turn components on and off.

Some electrical components which require a large amount of current to operate also have a relay in their circuit. Since these circuits carry a large amount of current, the thickness of the wire in the circuit (gauge size) is also greater. If this large wire were connected from the component to the control switch on the instrument panel, and then back to the component, a voltage drop would occur in the circuit. To prevent this potential drop in voltage, an electromagnetic switch (relay) is used. The large wires in the circuit are connected from the vehicle battery to one side of the relay, and from the opposite side of the relay to the component. The relay is normally open, preventing current from passing through the circuit. An additional, smaller wire is connected from the relay to the control switch for the circuit. When the control switch is turned on, it grounds the smaller wire from the relay and completes the circuit.

SHORT CIRCUITS

If you were to disconnect the light bulb (from the previous example of a light-bulb being connected to the battery by two wires) from the wires and touch the two wires together (please take our word for this; don't try it), the result will be a shower of sparks. A similar thing happens (on a smaller scale) when the power supply wire to a component or the electrical component itself becomes grounded before the normal ground connection for the circuit. To prevent damage to the system, the fuse for the circuit blows to interrupt the circuit — protecting the components from damage. Because grounding a wire from a power source makes a complete circuit — less the required component to use the power — the phenomenon is called a short circuit. The most common causes of short circuits are: the rubber insulation on a wire breaking or rubbing through to expose the current carrying core of the wire to a metal part of the car, or a shorted switch.

Some electrical systems on the vehicle are protected by a circuit breaker which is, basically, a self-repairing fuse. When either of the described events takes place in a system which is protected by a circuit breaker, the circuit breaker opens the circuit the same way a fuse does. However, when either the short is removed from the circuit or the surge subsides, the circuit breaker resets itself and does not have to be replaced as a fuse does.

Troubleshooting

When diagnosing a specific problem, organized troubleshooting is a must. The complexity of a modern automobile demands that you approach any problem in a logical, organized manner. There are certain troubleshooting techniques that are standard:

1. Establish when the problem occurs. Does the problem appear only under certain conditions? Were there any noises, odors, or other unusual symptoms?
2. Isolate the problem area. To do this, make some simple tests and observations; then eliminate the systems that are working properly. Check for obvious problems such as broken wires, dirty connections or split/disconnected vacuum hoses. Always check the obvious before assuming something complicated is the cause.
3. Test for problems systematically to determine the cause once the problem area is isolated. Are all the components functioning properly? Is there power going to electrical switches and motors? Is there vacuum at vacuum switches and/or actuators? Is there a mechanical problem such as bent linkage

or loose mounting screws? Performing careful, systematic checks will often turn up most causes on the first inspection without wasting time checking components that have little or no relationship to the problem.

4. Test all repairs after the work is done to make sure that the problem is fixed. Some causes can be traced to more than one component, so a careful verification of repair work is important in order to pick up additional malfunctions that may cause a problem to reappear or a different problem to arise. A blown fuse, for example, is a simple problem that may require more than another fuse to repair. If you don't look for a problem that caused a fuse to blow, a shorted wire (for example) may go undetected.

Experience has shown that most problems tend to be the result of a fairly simple and obvious cause, such as loose or corroded connectors or air leaks in the intake system. This makes careful inspection of components during testing essential to quick and accurate troubleshooting.

BASIC TROUBLESHOOTING THEORY

Electrical problems generally fall into one of three areas:

- The component that is not functioning is not receiving current.
- The component itself is not functioning.
- The component is not properly grounded.

Problems that fall into the first category are by far the most complicated. It is the current supply system to the component which contains all the switches, relay, fuses, etc.

The electrical system can be checked with a test light and a jumper wire. A test light is a device that looks like a pointed screwdriver with a wire attached to it. It has a light bulb in its handle. A jumper wire is a piece of insulated wire with an alligator clip attached to each end.

If a light bulb is not working, you must follow a systematic plan to determine which of the three causes is the villain.

1. Turn on the switch that controls the inoperable bulb.
2. Disconnect the power supply wire from the bulb.
3. Attach the ground wire to the test light to a good metal ground.
4. Touch the probe end of the test light to the end of the power supply wire that was disconnected from the bulb. If the bulb is receiving current, the test light will go on.

➡If the bulb is one which works only when the ignition key is turned on (turn signal), make sure the key is turned on.

If the test light does not go on, then the problem is in the circuit between the battery and the bulb. As mentioned before, this includes all the switches, fuses, and relays in the system. Turn to a wiring diagram and find the bulb on the diagram. Follow the wire that runs back to the battery. The problem is an open circuit between the battery and the bulb. If the fuse is blown and, when replaced, immediately blows again, there is a short circuit in the system which must be located and repaired. If there is a switch in the system, bypass it with a jumper wire. This is done by connecting one end of the jumper wire to the power supply wire into the switch and the other end of the jumper wire to the wire coming out of the switch. If the test light illuminates with the jumper wire installed, the switch or whatever was bypassed is defective.

➡Never substitute the jumper wire for the bulb, as the bulb is the component required to use the power from the power source.

5. If the bulb in the test light goes on, then the current is getting to the bulb that is not working in the car. This eliminates the first of the three possible causes. Connect the power supply wire and connect a jumper wire from the bulb to a good metal ground. Do this with the switch which controls the bulb works with jumper wire installed, then it has a bad ground. This is usually caused by the metal area on which the bulb mounts to the vehicle being coated with some type of foreign matter.
6. If neither test located the source of the trouble, then the light bulb itself is defective.

The above test procedure can be applied to any of the components of the chassis electrical system by substituting the component that is not working for the light bulb. Remember that for any electrical system to work, all connections must be clean and tight.

TEST EQUIPMENT

➡Pinpointing the exact cause of trouble in an electrical system can sometimes only be accomplished by the use of special test equipment. The following describes different types of commonly used test equipment and explains how to use them in diagnosis. In addition to the information covered below, the tool manufacturer's instructions booklet (provided with the tester) should be read and clearly understood before attempting any test procedures.

Jumper Wires

Jumper wires are simple, yet extremely valuable, pieces of test equipment. They are basically test wires which are used to bypass sections of a circuit. The simplest type of jumper wire is a length of multi-strand wire with an alligator clip at each end. Jumper wires are usually fabricated from lengths of standard automotive wire and whatever type of connector (alligator clip, spade connector or pin connector) that is required for the particular vehicle being tested. The well equipped tool box will have several different styles of jumper wires in several different lengths. Some jumper wires are made with three or more terminals coming from a common splice for special purpose testing. In cramped, hard-to-reach areas it is advisable to have insulated boots over the jumper wire terminals in order to prevent accidental grounding, sparks, and possible fire, especially when testing fuel system components.

Jumper wires are used primarily to locate open electrical circuits, on either the ground (-) side of the circuit or on the hot (+) side. If an electrical component fails to operate, connect the jumper wire between the component and a good ground. If the component operates only with the jumper installed, the ground circuit is open. If the ground circuit is good, but the component does not operate, the circuit between the power feed and component may be open. By moving the jumper wire successively back from the lamp toward the power source, you can isolate the area of the circuit where the open is located. When the component stops functioning, or the power is cut off, the open is in the segment of wire between the jumper and the point previously tested.

You can sometimes connect the jumper wire directly from the battery to the hot terminal of the component, but first make sure the component uses 12 volts in operation. Some electrical components, such as fuel injectors, are designed to operate on about 4 volts and running 12 volts directly to the injector terminals can cause damage.

By inserting an in-line fuse holder between a set of test leads, a fused jumper wire can be used for bypassing open circuits. Use a 5 amp fuse to provide protection against voltage spikes. When in doubt, use a voltmeter to check the voltage input to the component and measure how much voltage is normally being applied.

✱✱CAUTION

Never use jumpers made from wire that is of lighter gauge than that which is used in the circuit under test. If the jumper wire is of too small a gauge, it may overheat and possibly melt. Never use jumpers to bypass high resistance loads in a circuit. Bypassing resistances, in effect, creates a short circuit. This may, in turn, cause damage and fire. Jumper wires should only be used to bypass lengths of wire.

Unpowered Test Lights

The 12 volt test light is used to check circuits and components while electrical current is flowing through them. It is used for voltage and ground tests. Twelve volt test lights come in different styles but all have three main parts; a ground clip, a probe, and a light. The most commonly used 12 volt test lights have pick-type probes. To use a 12 volt test light, connect the ground clip to a good ground and probe wherever necessary with the pick. The pick should be sharp so that it can be probed into tight spaces.

✱✱CAUTION

Do not use a test light to probe electronic ignition spark plug or coil wires. Never use a pick-type test light to probe wiring on computer controlled systems unless specifically instructed to do so. Any wire insulation that is pierced by the test light probe should be taped and sealed with silicone after testing.

Like the jumper wire, the 12 volt test light is used to isolate opens in circuits. But, whereas the jumper wire is used to bypass the open to operate the load, the 12 volt test light is used to locate the presence of voltage in a circuit. If the test light glows, you know that there is power up to that point; if the 12 volt test light does not glow when its probe is inserted into the wire or connector, you know that there is an open circuit (no power). Move the test light in successive steps back toward the power source until the light in the handle does glow. When it glows, the open is between the probe and point which was probed previously.

➡The test light does not detect that 12 volts (or any particular amount of voltage) is present; it only detects that some voltage is present. It is advisable before using the test light to touch its terminals across the battery posts to make sure the light is operating properly.

Self-Powered Test Lights

The self-powered test light usually contains a 1.5 volt penlight battery. One type of self-powered test light is similar in design to the 12 volt unit. This type has both the battery and the light in the handle, along with a pick-type probe tip. The second type has the light toward the open tip, so that the light illuminates the contact point. The self-powered test light is a dual purpose piece of test equipment. It can be used to test for either open or short circuits when power is isolated from the circuit (continuity test). A powered test light should not be used on any computer controlled system or component unless specifically instructed to do so. Many engine sensors can be destroyed by even this small amount of voltage applied directly to the terminals.

Voltmeters

A voltmeter is used to measure voltage at any point in a circuit, or to measure the voltage drop across any part of a circuit. It can also be used to check continuity in a wire or circuit by indicating current flow from one end to the other. Analog voltmeters usually have various scales on the meter dial and a selector switch to allow the selection of different voltages. The voltmeter has a positive and a negative lead. To avoid damage to the meter, always connect the negative lead to the negative (-) side of the circuit (to ground or nearest the ground side of the circuit) and connect the positive lead to the positive (+) side of the circuit (to the power source or the nearest power source). Note that the negative voltmeter lead will always be black and that the positive voltmeter will always be some color other than black (usually red).

Depending on how the voltmeter is connected into the circuit, it has several uses. A voltmeter can be connected either in parallel or in series with a circuit and it has a very high resistance to current flow. When connected in parallel, only a small amount of current will flow through the voltmeter current path; the rest will flow through the normal circuit current path and the circuit will work normally. When the voltmeter is connected in series with a circuit, only a small amount of current can flow through the circuit. The circuit will not work properly, but the voltmeter reading will show if the circuit is complete or not.

Ohmmeters

The ohmmeter is designed to read resistance (which is measured in ohms or Ω) in a circuit or component. Although there are several different styles of ohmmeters, all analog meters will usually have a selector switch which permits the measurement of different ranges of resistance (usually the selector switch allows the multiplication of the meter reading by 10, 100, 1000, and 10,000). A calibration knob allows the meter to be set at zero for accurate measurement. Since all ohmmeters are powered by an internal battery, the ohmmeter can be used as a self-powered test light. When the ohmmeter is connected, current from the ohmmeter flows through the circuit or component being tested. Since the ohmmeter's internal resistance and voltage are known values, the amount of current flow through the meter depends on the resistance of the circuit or component being tested.

The ohmmeter can be used to perform a continuity test for opens or shorts (either by observation of the meter needle or as a self-powered test light), and to read actual resistance in a circuit. It should be noted that the ohmmeter is used to check the resistance of a component or wire while there is no voltage applied to the circuit. Current flow from an outside voltage source (such as the vehicle battery) can damage the ohmmeter, so the circuit or component should be isolated from the vehicle electrical system before any testing is done. Since the ohmmeter uses its own voltage source, either lead can be connected to any test point.

➡When checking diodes or other solid state components, the ohmmeter leads can only be connected one way in order to measure current flow in a single direction. Make sure the positive (+) and negative (-) terminal connections are as described in the test procedures to verify the one-way diode operation.

In using the meter for making continuity checks, do not be concerned with the actual resistance readings. Zero resistance, or any ohm reading, indicates continuity in the circuit. Infinite resistance indicates an open in the circuit. A high resistance reading where there should be none indicates a problem in the circuit. Checks for short circuits are made in the same manner as checks for open circuits except that the circuit must be isolated from both power and normal ground. Infinite resistance indicates no continuity to ground, while zero resistance indicates a dead short to ground.

Ammeters

An ammeter measures the amount of current flowing through a circuit in units called amperes or amps. Amperes are units of electron flow which indicate how fast the electrons are flowing through the circuit. Since Ohms Law dictates that current flow in a circuit is equal to the circuit voltage divided by the total circuit resistance, increasing voltage also increases the current level (amps). Likewise, any decrease in resistance will increase the amount of amps in a circuit. At normal operating voltage, most circuits have a characteristic amount of amperes, called "current draw" which can be measured using an ammeter. By referring to a specified current draw rating, measuring the amperes, and comparing the two values, one can determine what is happening within the circuit to aid in diagnosis. An open circuit, for example, will not allow any current to flow so the ammeter reading will be zero. More current flows through a heavily loaded circuit or when the charging system is operating.

An ammeter is always connected in series with the circuit being tested. All of the current that normally flows through the circuit must also flow through the ammeter; if there is any other path for the current to follow, the ammeter reading will not be accurate. The ammeter itself has very little resistance to current flow and therefore will not affect the circuit, but it will measure current draw only when the circuit is closed and electricity is flowing. Excessive current draw can blow fuses and drain the battery, while a reduced current draw can cause motors to run slowly, lights to dim and other components to not operate properly. The ammeter can help diagnose these conditions by locating the cause of the high or low reading.

Multimeters

Different combinations of test meters can be built into a single unit designed for specific tests. Some of the more common combination test devices are known as Volt/Amp testers, Tach/Dwell meters, or Digital Multimeters. The Volt/Amp tester is used for charging system, starting system or battery tests and consists of a voltmeter, an ammeter and a variable resistance carbon pile. The voltmeter will usually have at least two ranges for use with 6, 12 and/or 24 volt systems. The ammeter also has more than one range for testing various levels of battery loads and starter current draw. The carbon pile can be adjusted to offer different amounts of resistance. The Volt/Amp tester has heavy leads to carry large amounts of current and many later models have an inductive ammeter pickup that clamps around the wire to simplify test connections. On some models, the ammeter also has a zero-center scale to allow testing of charging and starting systems without switching leads or polarity. A digital multimeter is a voltmeter, ammeter and ohmmeter combined in an instrument which gives a digital readout. These are often used when testing solid state circuits because of their high input impedance (usually 10 megohms or more).

The tach/dwell meter that combines a tachometer and a dwell (cam angle) meter is a specialized kind of voltmeter. The tachometer scale is marked to show engine speed in rpm and the dwell scale is marked to show degrees of distributor shaft rotation. In most electronic ignition systems, dwell is determined by the control unit, but the dwell meter can also be used to check the duty cycle (operation) of some electronic engine control systems. Some tach/dwell meters are powered by an internal battery, while others take their power from the vehicle battery in use. The battery powered testers usually require calibration (much like an ohmmeter) before testing.

TESTING

Open Circuits

To use the self-powered test light or a multimeter to check for open circuits, first isolate the circuit from the vehicle's 12 volt power source by disconnecting the battery or wiring harness connector. Connect the test light or ohmmeter ground clip to a good ground and probe sections of the circuit sequentially with the test light. (start from either end of the circuit). If the light is out/or there is infinite resistance, the open is between the probe and the circuit ground. If the light is on/or the meter shows continuity, the open is between the probe and end of the circuit toward the power source.

Short Circuits

By isolating the circuit both from power and from ground, and using a self-powered test light or multimeter, you can check for shorts to ground in the circuit. Isolate the circuit from power and ground. Connect the test light or ohmmeter ground clip to a good ground and probe any easy-to-reach test point in the circuit. If the light comes on or there is continuity, there is a short somewhere in the circuit. To isolate the short, probe a test point at either end of the isolated circuit (the light should be on/there should be continuity). Leave the test light probe engaged and open connectors, switches, remove parts, etc., sequentially, until the light goes out/continuity is broken. When the light goes out, the short is between the last circuit component opened and the previous circuit opened.

➡The battery in the test light and does not provide much current. A weak battery may not provide enough power to illuminate the test light even when a complete circuit is made (especially if there are high resistances in the circuit). Always make sure that the test battery is strong. To check the battery, briefly touch the ground clip to the probe; if the light glows brightly the battery is strong enough for testing. Never use a self-powered test light to perform checks for opens or shorts when power is applied to the electrical system under test. The 12 volt vehicle power will quickly burn out the light bulb in the test light.

Available Voltage Measurement

Set the voltmeter selector switch to the 20V position and connect the meter negative lead to the negative post of the battery. Connect the positive meter lead to the positive post of the battery and turn the ignition switch **ON** to provide a load. Read the voltage on the meter or digital display. A well charged battery should register over 12 volts. If the meter reads below 11.5 volts, the battery power may be insufficient to operate the electrical system properly. This test determines voltage available from the battery and should be the first step in any electrical trouble diagnosis procedure. Many electrical problems, especially on computer controlled systems, can be caused by a low state of charge in the battery. Excessive corrosion at the battery cable terminals can cause a poor contact that will prevent proper charging and full battery current flow.

Normal battery voltage is 12 volts when fully charged. When the battery is supplying current to one or more circuits it is said to be "under load." When everything is off the electrical system is under a "no-load" condition. A fully charged battery may show about 12.5 volts at no load; will drop to 12 volts under medium load; and will drop even lower under heavy load. If the battery is partially discharged the voltage decrease under heavy load may be excessive, even though the battery shows 12 volts or more at no load. When allowed to discharge further, the battery's available voltage under load will decrease more severely. For this reason, it is important that the battery be fully charged during all testing procedures to avoid errors in diagnosis and incorrect test results.

Voltage Drop

When current flows through a resistance, the voltage beyond the resistance is reduced (the larger the current, the greater the reduction in voltage). When no current is flowing, there is no voltage drop because there is no current flow. All points in the circuit which are connected to the power source are at the same voltage as the power source. The total voltage drop always equals the total source voltage. In a long circuit with many connectors, a series of small, unwanted voltage drops due to corrosion at the connectors can add up to a total loss of voltage which impairs the operation of the normal loads in the circuit. The maximum allowable voltage drop under load is critical, especially if there is more than one high resistance problem in a circuit because all voltage drops are cumulative. A small drop is normal due to the resistance of the conductors.

INDIRECT COMPUTATION OF VOLTAGE DROPS

1. Set the voltmeter selector switch to the 20 volt position.
2. Connect the meter negative lead to a good ground.
3. While operating the circuit, probe all loads in the circuit with the positive meter lead and observe the voltage readings. A drop should be noticed after the first load. But, there should be little or no voltage drop before the first load.

DIRECT MEASUREMENT OF VOLTAGE DROPS

1. Set the voltmeter switch to the 20 volt position.
2. Connect the voltmeter negative lead to the ground side of the load to be measured.
3. Connect the positive lead to the positive side of the resistance or load to be measured.
4. Read the voltage drop directly on the 20 volt scale.

Too high a voltage indicates too high a resistance. If, for example, a blower motor runs too slowly, you can determine if perhaps there is too high a resistance in the resistor pack. By taking voltage drop readings in all parts of the circuit, you can isolate the problem. Too low a voltage drop indicates too low a resistance. Take the blower motor for example again. If a blower motor runs too fast in the MED and/or LOW position, the problem might be isolated in the resistor pack by taking voltage drop readings in all parts of the circuit to locate a possibly shorted resistor.

HIGH RESISTANCE TESTING

1. Set the voltmeter selector switch to the 4 volt position.
2. Connect the voltmeter positive lead to the positive post of the battery.
3. Turn on the headlights and heater blower to provide a load.
4. Probe various points in the circuit with the negative voltmeter lead.
5. Read the voltage drop on the 4 volt scale. Some average maximum allowable voltage drops are:
   - FUSE PANEL: 0.7 volts
   - IGNITION SWITCH: 0.5 volts
   - HEADLIGHT SWITCH: 0.7 volts
   - IGNITION COIL (+): 0.5 volts
   - ANY OTHER LOAD: 1.3 volts

➡Voltage drops are all measured while a load is operating; without current flow, there will be no voltage drop.

Resistance Measurement

The batteries in an ohmmeter will weaken with age and temperature, so the ohmmeter must be calibrated or "zeroed" before taking measurements. To zero the meter, place the selector switch in its lowest range and touch the two ohmmeter leads together. Turn the calibration knob until the meter needle is exactly on zero.

➡All analog (needle) type ohmmeters must be zeroed before use, but some digital ohmmeter models are automatically calibrated when the switch is turned on. Self-calibrating digital ohmmeters do not have an adjusting knob, but its a good idea to check for a zero readout before use by touching the leads together. All computer controlled systems require the use of a digital ohmmeter with at least 10 megohms impedance for testing. Before any test procedures are attempted, make sure the ohmmeter used is compatible with the electrical system or damage to the on-board computer could result.

To measure resistance, first isolate the circuit from the vehicle power source by disconnecting the battery cables or the harness connector. Make sure the key is **OFF** when disconnecting any components or the battery. Where necessary, also isolate at least one side of the circuit to be checked in order to avoid reading parallel resistances. Parallel circuit resistances will always give a lower reading than the actual resistance of either of the branches. When measuring the resistance of parallel circuits, the total resistance will always be lower than the smallest resistance in the circuit. Connect the meter leads to both sides of the circuit (wire or component) and read the actual measured ohms on the meter scale. Make sure the selector switch is set to the proper ohm scale for the circuit being tested to avoid misreading the ohmmeter test value.

✱✱WARNING

Never use an ohmmeter with power applied to the circuit. Like the self-powered test light, the ohmmeter is designed to operate on its own power supply. The normal 12 volt automotive electrical system current could damage the meter!

Wiring Harnesses

The average automobile contains about ½ mile of wiring, with hundreds of individual connections. To protect the many wires from damage and to keep them from becoming a confusing tangle, they are organized into bundles, enclosed in plastic or taped together and called wiring harnesses. Different harnesses serve different parts of the vehicle. Individual wires are color coded to help trace them through a harness where sections are hidden from view.

Automotive wiring or circuit conductors can be in any one of three forms:

1. Single strand wire
2. Multi-strand wire
3. Printed circuitry

Single strand wire has a solid metal core and is usually used inside such components as alternators, motors, relays and other devices. Multi-strand wire has a core made of many small strands of wire twisted together into a single conductor. Most of the wiring in an automotive electrical system is made up of multi-strand wire, either as a single conductor or grouped together in a harness. All wiring is color coded on the insulator, either as a solid color or as a colored wire with an identification stripe. A printed circuit is a thin film of copper or other conductor that is printed on an insulator backing. Occasionally, a printed circuit is sandwiched between two sheets of plastic for more protection and flexibility. A complete printed circuit, consisting of conductors, insulating material and connectors for lamps or other components is called a printed circuit board. Printed circuitry is used in place of individual wires or harnesses in places where space is limited, such as behind instrument panels.

Since automotive electrical systems are very sensitive to changes in resistance, the selection of properly sized wires is critical when systems are repaired. A loose or corroded connection or a replacement wire that is too small for the circuit will add extra resistance and an additional voltage drop to the circuit. A ten percent voltage drop can result in slow or erratic motor operation, for example, even though the circuit is complete. The wire gauge number is an expression of the cross-section area of the conductor. The most common system for expressing wire size is the American Wire Gauge (AWG) system.

Gauge numbers are assigned to conductors of various cross-section areas. As gauge number increases, area decreases and the conductor becomes smaller. A 5 gauge conductor is smaller than a 1 gauge conductor and a 10 gauge is smaller than a 5 gauge. As the cross-section area of a conductor decreases, resistance increases and so does the gauge number. A conductor with a higher gauge number will carry less current than a conductor with a lower gauge number.

➡Gauge wire size refers to the size of the conductor, not the size of the complete wire. It is possible to have two wires of the same gauge with different diameters because one may have thicker insulation than the other.

12 volt automotive electrical systems generally use 10, 12, 14, 16 and 18 gauge wire. Main power distribution circuits and larger accessories usually use 10 and 12 gauge wire. Battery cables are usually 4 or 6 gauge, although 1 and 2 gauge wires are occasionally used. Wire length must also be considered when making repairs to a circuit. As conductor length increases, so does resistance. An 18 gauge wire, for example, can carry a 10 amp load for 10 feet without excessive voltage drop; however if a 15 foot wire is required for the same 10 amp load, it must be a 16 gauge wire.

An electrical schematic shows the electrical current paths when a circuit is operating properly. It is essential to understand how a circuit works before trying to figure out why it doesn't. Schematics break the entire electrical system down into individual circuits and show only one particular circuit. In a schematic, no attempt is made to represent wiring and components as they physically appear on the vehicle; switches and other components are shown as simply as possible. Face views of harness connectors show the cavity or terminal locations in all multi-pin connectors to help locate test points.

If you need to backprobe a connector while it is on the component, the order of the terminals must be mentally reversed. The wire color code can help in this situation, as well as a keyway, lock tab or other reference mark.

WIRING REPAIR

Soldering is a quick, efficient method of joining metals permanently. Everyone who has the occasion to make wiring repairs should know how to solder. Electrical connections that are soldered are far less likely to come apart and will conduct electricity much better than connections that are only "pig-tailed" together. The most popular (and preferred) method of soldering is with an electrical soldering gun. Soldering irons are available in many sizes and wattage ratings. Irons with higher wattage ratings deliver higher temperatures and recover lost heat faster. A small soldering iron rated for no more than 50 watts is recommended, especially on electrical systems where excess heat can damage the components being soldered.

There are three ingredients necessary for successful soldering; proper flux, good solder and sufficient heat. A soldering flux is necessary to clean the metal of tarnish, prepare it for soldering and to enable the solder to spread into tiny crevices. When soldering, always use a rosin core solder which is non-corrosive and will not attract moisture once the job is finished. Other types of flux (acid core) will leave a residue that will attract moisture and cause the wires to corrode. Tin is a unique metal with a low melting point. In a molten state, it dissolves and alloys easily with many metals. Solder is made by mixing tin with lead. The most common proportions are 40/60, 50/50 and 60/40, with the percentage of tin listed first. Low priced solders usually contain less tin, making them very difficult for a beginner to use because more heat is required to melt the solder. A common solder is 40/60 which is well suited for all-around general use, but 60/40 melts easier and is preferred for electrical work.

Soldering Techniques

Successful soldering requires that the metals to be joined be heated to a temperature that will melt the solder, usually 360-460°F (182-238°C). Contrary to popular belief, the purpose of the soldering iron is not to melt the solder itself, but to heat the parts being soldered to a temperature high enough to melt the solder when it is touched to the work. Melting flux-cored solder on the soldering iron will usually destroy the effectiveness of the flux.

➡Soldering tips are made of copper for good heat conductivity, but must be "tinned" regularly for quick transference of heat to the project and to prevent the solder from sticking to the iron. To "tin" the iron, simply heat it and touch the flux-cored solder to the tip; the solder will flow over the hot tip. Wipe the excess off with a clean rag, but be careful as the iron will be hot.

After some use, the tip may become pitted. If so, simply dress the tip smooth with a smooth file and "tin" the tip again. Flux-cored solder will remove oxides but rust, bits of insulation and oil or grease must be removed with a wire brush or emery cloth. For maximum strength in soldered parts, the joint must start off clean and tight. Weak joints will result in gaps too wide for the solder to bridge.

If a separate soldering flux is used, it should be brushed or swabbed on only those areas that are to be soldered. Most solders contain a core of flux and separate fluxing is unnecessary. Hold the work to be soldered firmly. It is best to solder on a wooden board, because a metal vise will only rob the piece to be soldered of heat and make it difficult to melt the solder. Hold the soldering tip with the broadest face against the work to be soldered. Apply solder under the tip close to the work, using enough solder to give a heavy film between the iron and the piece being soldered, while moving slowly and making sure the solder melts properly. Keep the work level or the solder will run to the lowest part and favor the thicker parts, because these require more heat to melt the solder. If the soldering tip overheats (the solder coating on the face of the tip burns up), it should be retinned. Once the soldering is completed, let the soldered joint stand until cool. Tape and seal all soldered wire splices after the repair has cooled.

Wire Harness Connectors

Most connectors in the engine compartment or that are otherwise exposed to the elements are protected against moisture and dirt which could create oxidation and deposits on the terminals.

These special connectors are weather-proof. All repairs require the use of a special terminal and the tool required to service it. This tool is used to remove the pin and sleeve terminals. If removal is attempted with an ordinary pick, there is a good chance that the terminal will be bent or deformed. Unlike standard blade type terminals, these weather-proof terminals cannot be straightened once they are bent. Make certain that the connectors are properly seated and all of the sealing rings are in place when connecting leads. On some models, a hinge-type flap provides a backup or secondary locking feature for the terminals. Most secondary locks are used to improve connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Molded-on connectors require complete replacement of the connection. This means splicing a new connector assembly into the harness. All splices should be soldered to insure proper contact. Use care when probing the connections or replacing terminals in them as it is possible to short between opposite terminals. If this happens to the wrong terminal pair, it is possible to damage certain components. Always use jumper wires between connectors for circuit checking and never probe through weatherproof seals.

Open circuits are often difficult to locate by sight because corrosion or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may correct the open circuit condition. This should always be considered when an open circuit or a failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections. When using a circuit tester for diagnosis, always probe connections from the wire side. Be careful not to damage sealed connectors with test probes.

All wiring harnesses should be replaced with identical parts, using the same gauge wire and connectors. When signal wires are spliced into a harness, use wire with high temperature insulation only. It is seldom necessary to replace a complete harness. If replacement is necessary, pay close attention to insure proper harness routing. Secure the harness with suitable plastic wire clamps to prevent vibrations from causing the harness to wear in spots or contact any hot components.

➡Weatherproof connectors cannot be replaced with standard connectors. Instructions are provided with replacement connector and terminal packages. Some wire harnesses have mounting indicators (usually pieces of colored tape) to mark where the harness is to be secured.

In making wiring repairs, its important that you always replace damaged wires with wiring of the same gauge as the wire being replaced. The heavier the wire, the smaller the gauge number. Wires are color-coded to aid in identification and whenever possible the same color coded wire should be used for replacement. A wire stripping and crimping tool is necessary to install solderless terminal connectors. Test all crimps by pulling on the wires; it should not be possible to pull the wires out of a good crimp.

Wires which are open, exposed or otherwise damaged are repaired by simple splicing. Where possible, if the wiring harness is accessible and the damaged place in the wire can be located, it is best to open the harness and check for all possible damage. In an inaccessible harness, the wire must be bypassed with a new insert, usually taped to the outside of the old harness.

When replacing fusible links, be sure to use fusible link wire, NOT ordinary automotive wire. Make sure the fusible segment is of the same gauge and construction as the one being replaced and double the stripped end when crimping the terminal connector for a good contact. The melted (open) fusible link segment of the wiring harness should be cut off as close to the harness as possible, then a new segment spliced in as described. In the case of a damaged fusible link that feeds two harness wires, the harness connections should be replaced with two fusible link wires so that each circuit will have its own separate protection.

➡Most of the problems caused in the wiring harness are due to bad ground connections. Always check all vehicle ground connections for corrosion or looseness before performing any power feed checks to eliminate the chance of a bad ground affecting the circuit.

Hard-Shell Connectors

Unlike molded connectors, the terminal contacts in hard-shell connectors can be replaced. Weatherproof hard-shell connectors with the leads molded into the shell have non-replaceable terminal ends. Replacement usually involves the use of a special terminal removal tool that depresses the locking tangs (barbs) on the connector terminal and allows the connector to be removed from the rear of the shell. The connector shell should be replaced if it shows any evidence of burning, melting, cracks, or breaks. Replace individual terminals that are burnt, corroded, distorted or loose.

➡The insulation crimp must be tight to prevent the insulation from sliding back on the wire when the wire is pulled. The insulation must be visibly compressed under the crimp tabs, and the ends of the crimp should be turned in for a firm grip on the insulation.

The wire crimp must be made with all wire strands inside the crimp. The terminal must be fully compressed on the wire strands with the ends of the crimp tabs turned in to make a firm grip on the wire. Check all connections with an ohmmeter to insure a good contact. There should be no measurable resistance between the wire and the terminal when connected.

Fusible Links

The fuse link is a short length of special, Hypalon (high temperature) insulated wire, integral with the engine compartment wiring harness and should not be confused with standard wire. It is several wire gauges smaller than the circuit which it protects. Under no circumstances should a fuse link replacement repair be made using a length of standard wire cut from bulk stock or from another wiring harness.

To repair any blown fuse link use the following procedure:

1. Determine which circuit is damaged, its location and the cause of the open fuse link. If the damaged fuse link is one of three fed by a common No. 10 or 12 gauge feed wire, determine the specific affected circuit.
2. Disconnect the negative battery cable.
3. Cut the damaged fuse link from the wiring harness and discard it. If the fuse link is one of three circuits fed by a single feed wire, cut it out of the harness at each splice end and discard it.
4. Identify and procure the proper fuse link with butt connectors for attaching the fuse link to the harness.

➡Heat shrink tubing must be slipped over the wire before crimping and soldering the connection.

5. To repair any fuse link in a 3-link group with one feed:
   a. After cutting the open link out of the harness, cut each of the remaining undamaged fuse links close to the feed wire weld.
   b. Strip approximately ½ in. (13mm) of insulation from the detached ends of the two good fuse links. Insert two wire ends into one end of a butt connector, then carefully push one stripped end of the replacement fuse link into the same end of the butt connector and crimp all three firmly together.

➡Care must be taken when fitting the three fuse links into the butt connector as the internal diameter is a snug fit for three wires. Make sure to use a proper crimping tool. Pliers, side cutters, etc. will not apply the proper crimp to retain the wires and withstand a pull test.

   c. After crimping the butt connector to the three fuse links, cut the weld portion from the feed wire and strip approximately ½ in. (13mm) of insulation from the cut end. Insert the stripped end into the open end of the butt connector and crimp very firmly.
   d. To attach the remaining end of the replacement fuse link, strip approximately ½ in. (13mm) of insulation from the wire end of the circuit from which the blown fuse link was removed, and firmly crimp a butt connector or equivalent to the stripped wire. Then, insert the end of the replacement link into the other end of the butt connector and crimp firmly.
   e. Using rosin core solder with a consistency of 60 percent tin and 40 percent lead, solder the connectors and the wires at the repairs then insulate with electrical tape or heat shrink tubing.
6. To replace any fuse link on a single circuit in a harness, cut out the damaged portion, strip approximately ½ in. (13mm) of insulation from the two wire ends and attach the appropriate replacement fuse link to the stripped wire ends with two proper

size butt connectors. Solder the connectors and wires, then insulate.

7. To repair any fuse link which has an eyelet terminal on one end such as the charging circuit, cut off the open fuse link behind the weld, strip approximately ½ in. (13mm) of insulation from the cut end and attach the appropriate new eyelet fuse link to the cut stripped wire with an appropriate size butt connector. Solder the connectors and wires at the repair, then insulate.

8. Connect the negative battery cable to the battery and test the system for proper operation.

➡Do not mistake a resistor wire for a fuse link. The resistor wire is generally longer and has print stating, "Resistor-don't cut or splice."

When attaching a single No. 16, 17, 18 or 20 gauge fuse link to a heavy gauge wire, always double the stripped wire end of the fuse link before inserting and crimping it into the butt connector for positive wire retention.

Add-On Electrical Equipment

The electrical system in your vehicle is designed to perform under reasonable operating conditions without interference between components. Before any additional electrical equipment is installed, it is recommended that you consult your dealer or a reputable repair facility that is familiar with the vehicle and its systems.

If the vehicle is equipped with mobile radio equipment and/or mobile telephone, it may have an effect upon the operation of any on-board computer control modules. Radio Frequency Interference (RFI) from the communications system can be picked up by the vehicle's wiring harnesses and conducted into the control module, giving it the wrong messages at the wrong time. Although well shielded against RFI, the computer should be further protected by taking the following measures:

- Install the antenna as far as possible from the control module. For instance, if the module is located behind the center console area, then the antenna should be mounted at the rear of the vehicle.
- Keep the antenna wiring a minimum of eight inches away from any wiring running to control modules and from the module itself. NEVER wind the antenna wire around any other wiring.
- Mount the equipment as far from the control module as possible. Be very careful during installation not to drill through any wires or short a wire harness with a mounting screw.
- Insure that the electrical feed wire(s) to the equipment are properly and tightly connected. Loose connectors can cause interference.
- Make certain that the equipment is properly grounded to the vehicle. Poor grounding can damage expensive equipment.

SUPPLEMENTAL RESTRAINT SYSTEMS (SRS)

If your vehicle is equipped with a Supplemental Restraint System (SRS) commonly referred to as an Air Bag. DO NOT attempt to service the vehicle or any of its electronic components before reading the precautions in this section.

✻✻CAUTION

Some 1987-89 Volvo 760 and 780 vehicles include an electrically operated Supplemental Restraint System (SRS) or air bag system. The SRS system can deploy during electrical testing if certain steps are not followed. While the air bag and inflator are in the steering column, the system has various other wires and components located under the dash and under the seat.

Precautions

➧ See Figures 1 and 2

If your car is equipped with SRS, observe the following rules when performing electrical diagnosis:

- If you are not absolutely sure of the identity of a component, leave it alone.
- Know where a wire goes before applying voltage or checking resistance.
- Turn the ignition to **OFF** and disconnect the negative battery cable before disconnecting any wiring or electrical connectors inside the car.
- Be sure that the integrity of the SRS wiring is not disturbed during the installation of accessories such as CB radios, phones, audio equipment, etc.
- If the steering wheel must be removed, the bag assembly must first be removed and disconnected from the center of the wheel. Put the unit to the side and DO NOT attempt to check resistance at the inflator.
- On 780 series, ALWAYS disconnect the 4-pin yellow connector at the lower part of the steering column near the center console. The front seat belts are also part of the SRS system. If any diagnostics must be done to the seat belt system, disconnect the seat belt tensioners (grey connectors under the driver's seat) before doing any work.
- On the 760 series, ALWAYS disconnect the 4-pin yellow connector (shown below) before doing ANY electrical diagnostic work.
- Do not disconnect the main lead to the sensor box under the seat.
- Volvo specifically recommends against anyone other than factory-trained personnel attempting repairs or diagnosis on the SRS system.

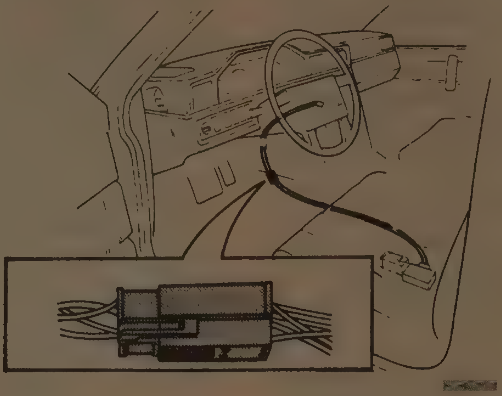


Fig. 1 Always unplug the yellow connector before performing any electrical diagnostic work — 1988 760 with SRS shown

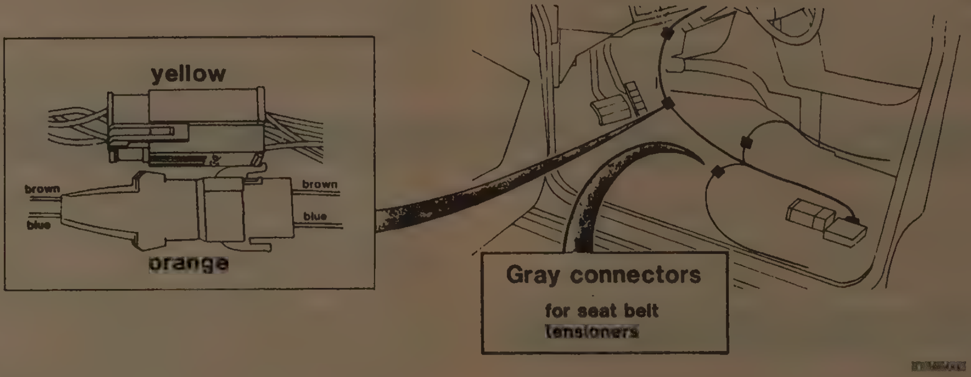


Fig. 2 Location of SRS connectors — 1987 780 shown

HEATING AND AIR CONDITIONING

Heater/Air Conditioner Blower Motor

REMOVAL & INSTALLATION

1970-72 164 Models

1. Remove the heater unit as outlined in Heater Unit Removal and Installation.
2. Remove the four rubber bushings on the sides of the heater unit.
3. Scribe marks on both sides of the fan housing to ease reassembly. Remove the spring clips and separate the housing halves.
4. Mark the mounting plate's relative position to the fan housing. Straighten the tabs and separate the mounting plate from the housing.
5. Remove the retaining screws and separate the fan motor from the mounting plate.
6. Reverse the above procedure to install, being careful to apply soft sealer to the housing halves.

1800 Series

➡The fan motor and fan are replaced as a unit.

1. Remove the valve cover and place a rag over the rocker arm assembly.
2. On 1970-71 models, remove the pressure regulator bracket from the heater and allow it to hang freely.
3. Disconnect the fan motor wires at the fan terminals.
4. Remove the six retaining screws and remove the fan motor from the heater assembly.
5. Reverse the above procedure to install.

1973 140 Series and 164 Models

WITHOUT AIR CONDITIONING

➧ See Figures 3 and 4

1. Remove the heater unit as outlined in Heater Unit Removal and Installation.
2. Place the unit on its side with the control valve facing upward. Remove the spring clips and separate the housing valves.
3. Lift out the old fan motor and replace it with a new unit, making sure that the support leg without the foot points to the output for the defroster channel. (See illustration).
4. Assemble the heater housing halves with new spring clips, and seal the joint without clips using soft sealing compound.
5. Install the heater unit as outlined in Heater Unit Removal and Installation.

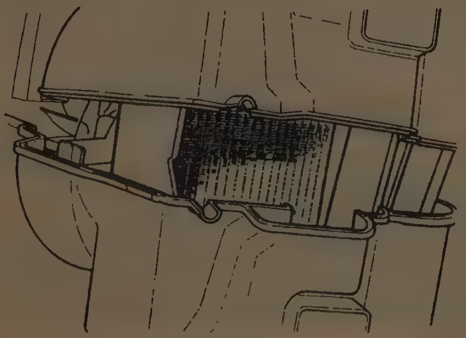


Fig. 3 Use care in separating the case halves

WITH AIR CONDITIONING

➧ See Figure 5

In order to remove the blower motor, both the right and left turbines (blower wheels) must first be removed. The heater unit does not have to be removed.

1. Disconnect the negative battery cable.
2. Lift the carpet and remove the central unit side panels.
3. Remove the retaining screws for the control panel and move the panel as far back on the transmission tunnel as the electrical cables will permit.
4. Remove the attaching screws for the rear seat heater ducts and disconnect the ducts from the central unit.
5. Remove the instrument cluster as outlined in Instrument Cluster Removal and Installation.
6. Remove the glovebox by unscrewing the four attaching screws, removing the glovebox door stop, and disconnecting the wires from the glovebox courtesy light. Remove the molded dashboard padding from beneath the glovebox.
7. Disconnect the vacuum hoses to the left and right defroster vacuum motors, then remove the nozzles and both air ducts.
8. Remove the air hoses between the left and right inside air vents.
9. Remove the clamps on the central unit outer ends and remove the ends.
10. Pry off the locking retainer from the turbines (blower wheels), and remove both left and right turbines.
11. Position the heater control valve capillary tube to one side.
12. Remove the left inner end (blower housing) from the central unit.
13. Unscrew the three retaining screws and remove the fan motor retainer.
14. Disconnect the plug from the fan motor control panel. Release the tabs of the electric cables from the plug contact, remove the rubber grommet, and pull the electric cables down through right side opening of the central unit.
15. Remove the fan motor from the left opening.

To install:

16. When reinstalling, pass the cable through the opening, connect it and replace the rubber grommet.

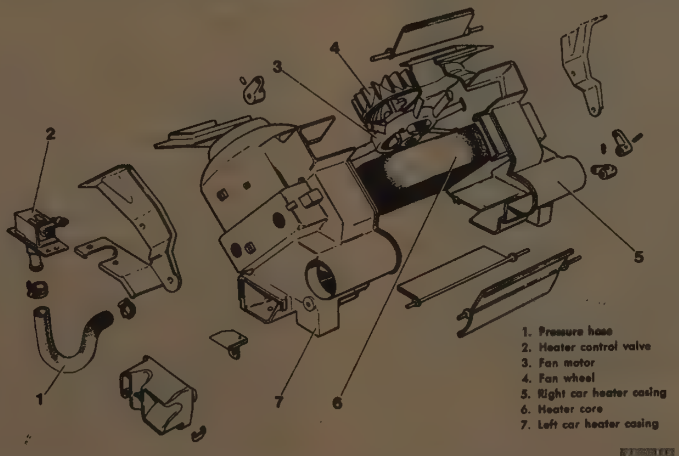
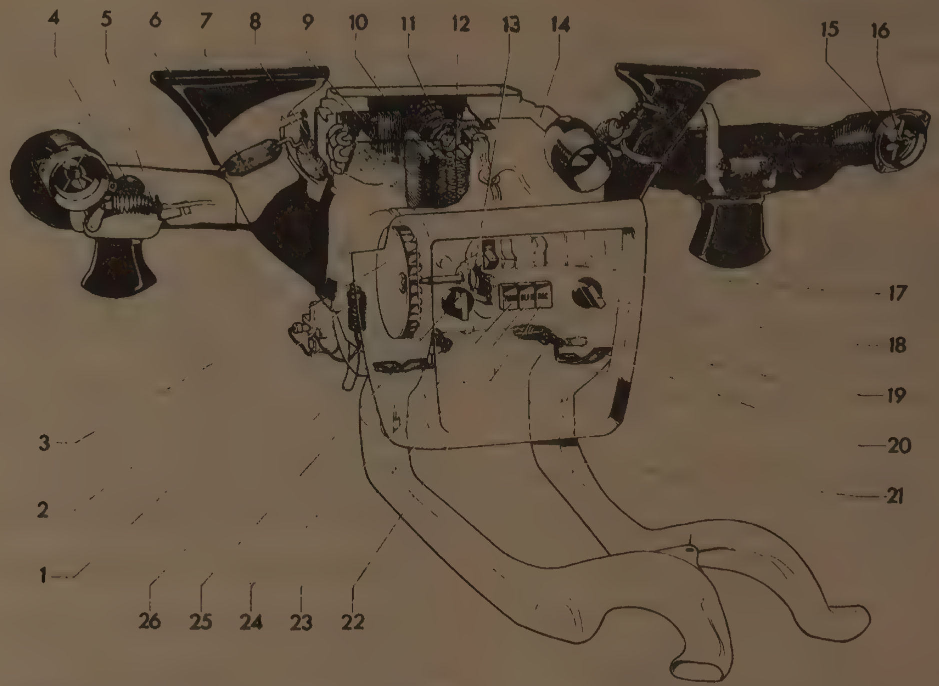


Fig. 4 Exploded view of the heater unit — 1973 140 series and 164 series without air conditioning



1. Heater control valve
2. Capillary tube for heater control valve
3. Turbine
4. Shutter, air vent left floor
5. Vacuum motor
6. Shutter, left defroster nozzle
7. Return spring for vacuum motor
8. Vacuum motor
9. Evaporator (only on vehicles with air conditioning)
10. Air intake cover
11. Vacuum motor for air intake cover
12. Heater core
13. Fan motor
14. Central unit
15. Blow-in valve
16. Shutter knob
17. Air conditioning switch
18. Fan motor switch
19. Vacuum motor
20. Shutter, right air duct, rear floor
21. Air duct to rear floor
22. Knob, air intake cover
23. Knob, defroster shutter
24. Knob, floor shutter
25. Temperature controls
26. Drain hose

Fig. 5 Details of the heater/air conditioning unit — 1973 140 series and 164 with A/C, as well as all 1974 and later models except the 700 series

17. Mount and secure the fan motor. Remember to install the plastic bushings on the fan mounts; failure to do so will make the fan rub the case.
18. Reinstall the inner casing (housing) and hook up the capillary tube.
19. Reinstall the blower wheels and secure the locking clip. Install the outer ends of the central unit and attach their clips.
20. Connect the ductwork to the inside air vents. Reinstall the defroster nozzles and connect the vacuum hoses to the vacuum motors.
21. Replace the molded insulation and reassemble the glovebox.
22. Reinstall the instrument cluster.
23. Connect and secure the rear seat heating ducts. Slide the control panel back towards the dash and into position.
24. Install the central unit side panels. Reconnect the negative battery cable.

1974 and Later Models Except 700 Series

➧ See Figures 5, 6, 7, 8, 9, 10, 11, 12 and 13

In order to remove the blower motor, both the right and left turbines (blower wheels) must first be removed. The heater unit does not have to be removed.

1. Disconnect the negative battery cable.
2. Lift the carpet and remove the central unit side panels.
3. Remove the retaining screws for the control panel and move the panel as far back on the transmission tunnel as the electrical cables will permit.
4. Remove the attaching screws for the rear seat heater ducts and disconnect the ducts from the central unit.
5. Remove the instrument cluster as outlined in Instrument Cluster Removal and Installation.
6. Remove the glovebox by unscrewing the four attaching screws, removing the glovebox door stop, and disconnecting the wires from the glovebox courtesy light. Remove the molded dashboard padding from beneath the glovebox.

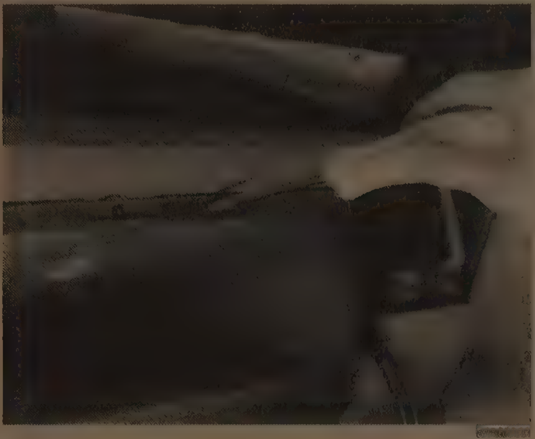


Fig. 6 Unscrew the glovebox — be sure to have an undisturbed location to save hardware for reinstallation

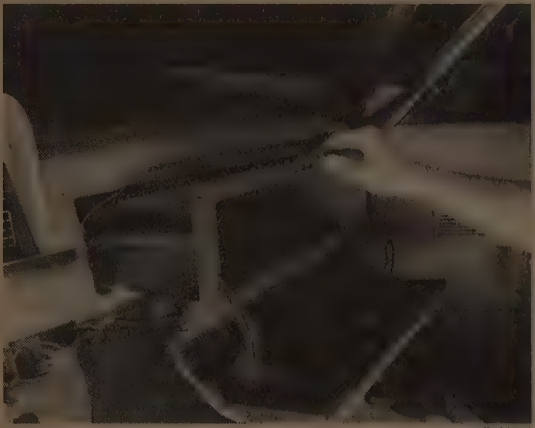


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Fig. 7 Pull out the glovebox, disconnect the courtesy light, then remove the glovebox

7. Disconnect the vacuum hoses to the left and right defroster vacuum motors, then remove the nozzles and both air ducts.
8. Remove the air hoses between the left and right inside air vents.
9. Remove the clamps on the central unit outer ends and remove the ends.
10. Pry off the locking retainer from the turbines (blower wheels), and remove both left and right turbines.
11. Position the heater control valve capillary tube to one side.
12. Remove the left inner end (blower housing) from the central unit.
13. Unscrew the three retaining screws and remove the fan motor retainer.
14. Disconnect the plug from the fan motor control panel. Release the tabs of the electric cables from the plug contact, remove the rubber grommet, and pull the electric cables down through right side opening of the central unit.
15. Remove the fan motor from the left opening.

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Fig. 8 Remove the nozzles and both air ducts

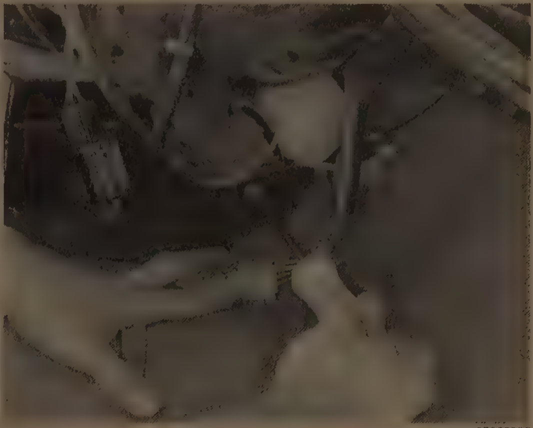

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Fig. 9 Remove any screws used to secure the turbine case halves together

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Fig. 10 Use a small prytool to remove the clips that hold the case halves together

Fig. 11 Maneuver the case half past any wires and set it aside

Fig. 12 Remove the fastener that holds the turbine to its shaft

Fig. 13 Remove the turbine to allow removal of the electric motor

To install:

16. When reinstalling, pass the cable through the opening, connect it and replace the rubber grommet.
17. Mount and secure the fan motor. Remember to install the plastic bushings on the fan mounts; failure to do so will make the fan rub the case.
18. Reinstall the inner casing (housing) and hook up the capillary tube.
19. Reinstall the blower wheels and secure the locking clip. Install the outer ends of the central unit and attach their clips.
20. Connect the ductwork to the inside air vents. Reinstall the defroster nozzles and connect the vacuum hoses to the vacuum motors.
21. Replace the molded insulation and reassemble the glovebox.
22. Reinstall the instrument cluster.
23. Connect and secure the rear seat heating ducts. Slide the control panel back towards the dash and into position.
24. Install the central unit side panels. Reconnect the negative battery cable.

740, 760 and 780 Models

➧ See Figures 14, 15 and 16

The 700 series of Volvos may be found equipped with any of three heating and air conditioning systems. The combined unit (CU) is simply a manually operated heater, with or without an air conditioner system. The Automatic Climate Control (ACC) system maintains a constant (preset) temperature in the car by mechanical (vacuum) means, turning on the heater or A/C as necessary. The newer Electronic Climate Control (ECC) system performs the same duties electronically and incorporates an internal self-diagnostic system which will display a signal when it detects a fault. To remove the blower motor:

1. Disconnect the negative battery cable.
2. Remove the panel below the glove compartment. Depending on the model, it may be necessary to remove the glove box.
3. On cars with the CU system, remove the right sill plate and the right kick panel. Carefully disconnect the control unit connector, remove the mounting screws and remove the control unit with its bracket.

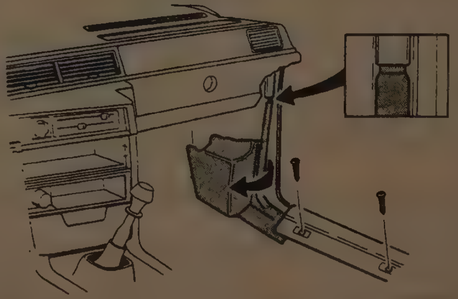

Fig. 14 Remove the indicated panels to access the CU system

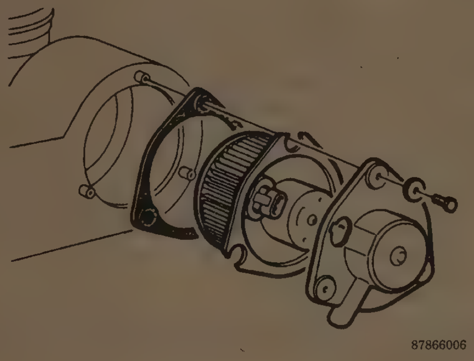

Fig. 15 Exploded view of the blower assembly — ECC system

4. Disconnect the wiring to the fan motor, unfasten the screws securing the fan motor, and lower the motor.
5. Remove the motor and fan.

To install:

6. Reconnect the wiring to the fan motor. Spread a sealer around the mounting face of the fan mounting flange, and install the fan motor. Cars with ECC have a rubber seal between the motor and the fan case; no sealer is required.
7. Reconnect the breather hose to the motor and connect the negative battery cable. Check the fan operation.
8. Reinstall the control unit and secure its connector on cars with the CU system. Replace the right kick panel and the sill plate.
9. Reinstall the panel below the glove compartment and the glove box if removed.

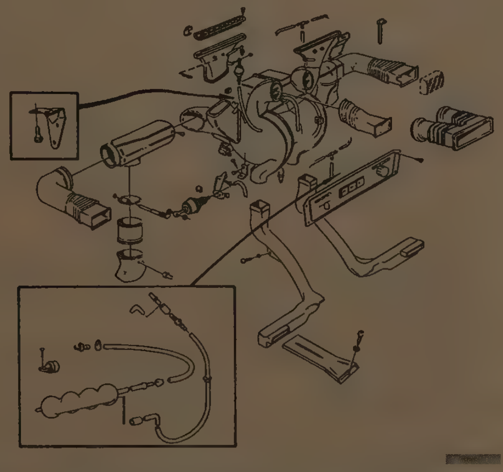

Fig. 16 Exploded view of the CU heater system

Heater Unit (Complete Assembly)

REMOVAL & INSTALLATION

1970-72 140 Series and 164

➧ See Figure 17

1. Remove the lower radiator hose, open the engine drain plug, and drain the cooling system. Disconnect the negative battery cable.
2. Remove the hoses to the heater control valve.
3. Remove the heater control panel below the dashboard by removing the two retaining screws. Tilt the top of the panel back so that it loosens from the dashboard clips and clears the hood release.
4. Remove the transmission tunnel mat, defroster hoses, heater control cables, and fan switch wires.
5. Remove the two screws which retain the fuse box to the heater.
6. Remove the control valve, being careful not to damage the copper capillary tube. Loosen the upper hose to the heater.
7. Plug the heater outlets to avoid spilling coolant upon removal. Loosen the heater unit ground cables, remove the four retaining screws, loosen the drain hose, and lift out the heater unit and control valve from their brackets.

To install:

8. Reverse the above procedure to install. Remember to remove all plugs from lines and ports. When reinstalling, support the unit and handle it carefully so the capillary tube is not damaged. Double check the security of all hose clamps and wiring connectors.
9. Carefully refit the control panel and install its screws. Connect the hoses to the heater control valve.
10. Reconnect the negative battery cable and fill the system with coolant.

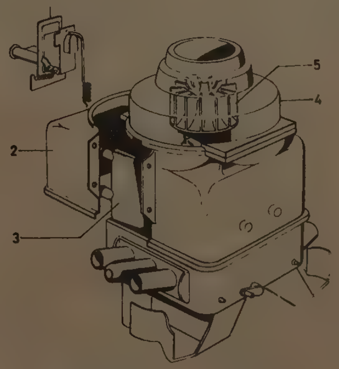

Fig. 17 Details of the heater unit — 1970-72 140 series; 164 models are similar

1800 Series

1. Disconnect the lower radiator hose, open the engine drain plug, and drain the cooling system. Disconnect the negative battery cable.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Disconnect the heater hoses from the heater core pipe and the control valve pipe. Disconnect the fan motor wires.
3. Disconnect the fresh air intake from the heater.
4. On 1970-71 models, remove the pressure regulator bracket retaining screws and allow the pressure regulator to hang free while still connected to the hoses.
5. Remove the four heater-to-firewall attaching nuts.
6. Remove the defroster hoses. Disconnect the heater control valve and the control cables.
7. Lift out the heater and control valve as a unit.
8. Reverse the above procedure to install.

1973 140 Series and 164 Models

WITHOUT AIR CONDITIONING

1. Remove the lower radiator hose, open the engine drain plug, and drain the cooling system. Disconnect the negative battery cable.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Remove the center panel and the left-hand defroster hose.
3. Lift up the driveshaft tunnel mat, disconnect the front and rear attaching screws for the rear seat heater ducts and then remove the ducts.
4. Disconnect the heater control valve and air-mix cables from their shutters.
5. Disconnect and plug the pressure hose at the heater. Also plug the heater pipes to prevent residual coolant from spilling onto the carpet.
6. Remove the attaching screws which secure the left-hand upper bracket to the dashboard and the left-hand lower bracket to the transmission tunnel.
7. Remove the glovebox by unscrewing the four attaching screws, removing the glovebox door stop, and disconnecting the wires from the glovebox courtesy light.
8. Disconnect the defroster and floor heating cables from their levers.
9. Disconnect the fan motor wires at the switch contact plate.
10. Remove the attaching screws which secure the right-hand upper bracket to the dashboard and the right-hand lower bracket to the transmission tunnel.
11. Remove the right-hand defroster hose. Disconnect the hose between the heater and the dashboard circular vents. Lift the heater unit to the right, and then out of the vehicle.
12. Reverse the above procedure to install, taking care to ensure that the air vent rubber seal is properly located, and that the fan motor ground cable is attached at the upper right-hand bracket attaching screw.

WITH AIR CONDITIONING

➡This procedure does NOT require the discharge of the air conditioning system. Do not disconnect any A/C lines or hoses.

1. Remove the lower radiator hose, open the engine drain plug, and drain the cooling system. Disconnect the negative battery cable.

****CAUTION**

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Remove the heater hoses from the heater pipes at the engine side of the firewall. Plug the heater pipes.
3. Remove the evaporator hose brackets from their body mounts and disconnect the dryer from its bracket. Position the dryer as close to the firewall as the evaporator hose permits. Do not disconnect any air conditioning lines.
4. Remove the instrument cluster by removing the steering column molded casting, removing the bracket retaining screw and lowering it toward the steering column. Remove the four instrument cluster retaining screws, disconnecting the speedometer cable and tilting the speedometer out of its snap fitting. After moving the cluster forward and disconnecting the electrical plug contacts, lift the cluster out of the vehicle.
5. Remove the air hose between the center unit and the left inner air vent. Remove the hose from the vacuum motor for the left defroster nozzle and the left floor outlet (if equipped).
6. Remove the left-side panel from the central unit.
7. Lift up the driveshaft tunnel mat and disconnect the rear seat heater duct from the central unit.
8. Remove the heater pipes from the firewall.
9. Remove the upper and lower attaching screws for the left support leg. Remove the attaching screws which secure the upper bracket to the dashboard and the lower bracket to the transmission tunnel.

➡If the upper bracket screw holes are slotted, the screws need only be slackened a few turns.

10. Remove the right-side panel from the central unit.

11. Remove the glovebox by unscrewing the four attaching screws, removing the glovebox door stop, and disconnecting the glovebox courtesy light wires.
12. Remove the right defroster nozzle and the air hose between the central unit and the right inner air vent.
13. Lift up the driveshaft tunnel mat and disconnect the rear seat heater duct from the central unit.
14. Remove the upper and lower attaching screws from the right support leg. Remove the lower attaching screws for the control panel.
15. Disconnect the fan motor wires and the ground wires from the control panel.
16. Disconnect the yellow cable from its plug contact.
17. Separate the halves of the vacuum hose connector and disconnect the vacuum tank hose at the connector.
18. Position the control panel as far back on the transmission tunnel as the cables permit.
19. Remove the screws which attach the upper brackets to the firewall and the lower brackets to the transmission tunnel.
20. Remove the thermostat clamp from the central unit, and the two evaporator cover retaining clamps.
21. Without disconnecting any of the refrigerant lines, remove the evaporator from the central unit, placing it on the right-hand side of the firewall.
22. Remove the molded dashboard padding from beneath the glovebox if it's in the way.
23. Remove the retaining clamps for the right outer vent duct, and remove the duct. Pry off the locking retainer for the turbine (blower), and remove the turbine. Remove the clamps which retain the blower housing (inner end) to the central unit and remove the housing.
24. Remove the passenger's front seat (if it's in the way) and lift the central unit forward and onto the floor of the vehicle. Be careful not to place undue stress on the connected refrigerant lines.
25. When reinstalling the central unit,lift it onto the right floor and install the rubber seal for the air intake. Lift the unit into position and insert the upper left bracket over the dashboard screws. Install the right side bracket screws and tighten the left ones.
26. Install the evaporator, cover it and secure the clamps. Carefully reinstall the thermostat on the loser flange.
27. Use a sealing compound around the evaporator pipes and the thermostat line as necessary.
28. Install the ducts for the heater hoses to the dashboard.
29. Install the tunnel brackets and the drain hose.
30. Install the right inner end of the unit and the vacuum hose for the floor shutter.
31. Install the turbine wheel (fan) and the outer end of the central unit. Make sure the clips are reinstalled properly.
32. Install the air duct between the central unit and the right inner air outlet.
33. Install the right defroster nozzle and connect its vacuum hose.
34. Install the glove box, the air duct to the right side vent, and the air ducts to the rear floor.
35. Connect the air duct for the left inner air vent, connect and adjust the left defroster nozzle and attach its vacuum line.
36. Replace the instrument cluster.
37. Reassemble the vacuum connectors and connect the hoses to the vacuum tank.
38. Reconnect the yellow wire to the contact unit and the contact to the control unit.
39. Install the ground wires, tighten the instrument cluster and the support legs.
40. Reinstall the control panel, the insulation pads and the side panels.
41. Connect the heater hoses to the ports on the control unit. Install the firewall panel and clamp down the air conditioning hoses and dryer in the engine compartment.
42. Refill the engine coolant.
43. Double check all installation items, paying particular attention to loose hoses or hanging wires, improperly tightened nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the area.
44. Reconnect the battery and check the function of the system components.

1974 and Later Models Except 700 Series

➡This procedure does NOT require the discharge of the air conditioning system. Do not disconnect any A/C lines or hoses.

1. Remove the lower radiator hose, open the engine drain plug, and drain the cooling system. Disconnect the negative battery cable.

✲✲CAUTION

When draining the coolant, keep in mind that cats and dogs are attracted by ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Remove the heater hoses from the heater pipes at the engine side of the firewall. Plug the heater pipes.
3. Remove the evaporator hose brackets from their body mounts and disconnect the dryer from its bracket. Position the dryer as close to the firewall as the evaporator hose permits. Do not disconnect any air conditioning lines.
4. Remove the instrument cluster by removing the steering column molded casting, removing the bracket retaining screw and lowering it toward the steering column. Remove the four instrument cluster retaining screws, disconnecting the speedometer cable and tilting the speedometer out of its snap fitting. After moving the cluster forward and disconnecting the electrical plug contacts, lift the cluster out of the vehicle.
5. Remove the air hose between the center unit and the left inner air vent. Remove the hose from the vacuum motor for the left defroster nozzle and the left floor outlet (if equipped).
6. Remove the left-side panel from the central unit.
7. Lift up the driveshaft tunnel mat and disconnect the rear seat heater duct from the central unit.
8. Remove the heater pipes from the firewall.
9. Remove the upper and lower attaching screws for the left support leg. Remove the attaching screws which secure

the upper bracket to the dashboard and the lower bracket to the transmission tunnel.

➡If the upper bracket screw holes are slotted, the screws need only be slackened a few turns.

10. Remove the right-side panel from the central unit.
11. Remove the glovebox by unscrewing the four attaching screws, removing the glovebox door stop, and disconnecting the glovebox courtesy light wires.
12. Remove the right defroster nozzle and the air hose between the central unit and the right inner air vent.
13. Lift up the driveshaft tunnel mat and disconnect the rear seat heater duct from the central unit.
14. Remove the upper and lower attaching screws from the right support leg. Remove the lower attaching screws for the control panel.
15. Disconnect the fan motor wires and the ground wires from the control panel.
16. Disconnect the yellow cable from its plug contact.
17. Separate the halves of the vacuum hose connector and disconnect the vacuum tank hose at the connector.
18. Position the control panel as far back on the transmission tunnel as the cables permit.
19. Remove the screws which attach the upper brackets to the firewall and the lower brackets to the transmission tunnel.
20. Remove the thermostat clamp from the central unit, and the two evaporator cover retaining clamps.
21. Without disconnecting any of the refrigerant lines, remove the evaporator from the central unit, placing it on the right-hand side of the firewall.
22. Remove the molded dashboard padding from beneath the glovebox if it's in the way.
23. Remove the retaining clamps for the right outer vent duct, and remove the duct. Pry off the locking retainer for the turbine (blower), and remove the turbine. Remove the clamps which retain the blower housing (inner end) to the central unit and remove the housing.
24. Remove the passenger's front seat (if it's in the way) and lift the central unit forward and onto the floor of the vehicle. Be careful not to place undue stress on the connected refrigerant lines.
25. When reinstalling the central unit,lift it onto the right floor and install the rubber seal for the air intake. Lift the unit into position and insert the upper left bracket over the dashboard screws. Install the right side bracket screws and tighten the left ones.
26. Install the evaporator, cover it and secure the clamps. Carefully reinstall the thermostat on the loser flange.
27. Use a sealing compound around the evaporator pipes and the thermostat line as necessary.
28. Install the ducts for the heater hoses to the dashboard.
29. Install the tunnel brackets and the drain hose.
30. Install the right inner end of the unit and the vacuum hose for the floor shutter.
31. Install the turbine wheel (fan) and the outer end of the central unit. Make sure the clips are reinstalled properly.
32. Install the air duct between the central unit and the right inner air outlet.
33. Install the right defroster nozzle and connect its vacuum hose.
34. Install the glove box, the air duct to the right side vent, and the air ducts to the rear floor.
35. Connect the air duct for the left inner air vent, connect and adjust the left defroster nozzle and attach its vacuum line.
36. Replace the instrument cluster.
37. Reassemble the vacuum connectors and connect the hoses to the vacuum tank.
38. Reconnect the yellow wire to the contact unit and the contact to the control unit.
39. Install the ground wires, tighten the instrument cluster and the support legs.
40. Reinstall the control panel, the insulation pads and the side panels.
41. Connect the heater hoses to the ports on the control unit. Install the firewall panel and clamp down the air conditioning hoses and dryer in the engine compartment.
42. Refill the engine coolant.
43. Double check all installation items, paying particular attention to loose hoses or hanging wires, improperly tightened nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the area.
44. Reconnect the battery and check the function of the system components.

Heater Core

REMOVAL & INSTALLATION

1970-72 140 Series and 164

1. Remove the heater unit as outlined in Heater Unit Removal and Installation.
2. Remove the four rubber bushings on the sides of the heater unit.
3. Scribe marks on both sides of the fan housing to facilitate assembly. Remove the spring clips and separate the housing halves.
4. Separate the heater core from the housing half, taking care not to damage the sensitive body of the control valve.
5. Reverse the above procedure to install, being careful to apply soft sealer to the housing halves.

1800 Series

1. Remove the heater unit as outlined in Heater Unit Removal and Installation.
2. Remove the fan motor.
3. Remove the screws securing the heater housing halves together and then separate the halves.
4. Remove the heater core from the housing.
5. Install the new or reconditioned core in the housing. Check the operation of the shutters for binding or looseness.
6. Install the thermostat capillary tube on the core.
7. Apply new soft sealing compound to the housing halves prior to assembly.
8. Reinstall the fan motor and install the heater unit as explained in "Heater Unit Removal and Installation".

1973 140 Series and 164

WITHOUT AIR CONDITIONING

1. Remove the heater unit as outlined in Heater Unit Removal and Installation.

2. Place the unit on its side with the control valve facing upward. Remove the spring clips and separate the housing halves.
3. Disconnect the capillary tube from the heater core and then lift out the core.
4. Reverse the above procedure to install, being careful to transfer the foam plastic packing to the new heater core, and to install the fragile capillary tube carefully on the core.

WITH AIR CONDITIONING

1. Remove the heater-air conditioner unit as outlined under Heater Unit Removal and Installation.
2. Remove the left outer end of the central unit. Remove the locking retainer and the turbine (blower wheel).
3. Remove the two retaining screws for the left transmission tunnel bracket.
4. Remove the lockring for the left intake shutter shaft.
5. Remove the three retaining screws and lift off the inner end.
6. Remove the three retaining screws for the fan motor retainer.
7. Disconnect the heater hoses at the heater core.
8. Remove the clamps which retain the central unit halves together, lift off the left half, and remove the heater core.
9. Reverse the above procedure to install, taking care to transfer the foam plastic packing to the new heater core.

1974 and Later Models Except 700 Series

1. Remove the heater-air conditioner unit as outlined under Heater Unit Removal and Installation.
2. Remove the left outer end of the central unit. Remove the locking retainer and the turbine (blower wheel).
3. Remove the two retaining screws for the left transmission tunnel bracket.
4. Remove the lockring for the left intake shutter shaft.
5. Remove the three retaining screws and lift off the inner end.
6. Remove the three retaining screws for the fan motor retainer.
7. Disconnect the heater hoses at the heater core.
8. Remove the clamps which retain the central unit halves together, lift off the left half, and remove the heater core.
9. Reverse the above procedure to install, taking care to transfer the foam plastic packing to the new heater core.

700 Series

On vehicles equipped with Automatic Climate Control (ACC), a thermal switch is located on the outlet hose from the heater core. It switches on and starts the fan motor only when the water temperature exceeds approximately 95°F (35°C). This prevents cold air from being blown into the passenger compartment during winter. The thermal switch is bypassed in the DEFROST position.

740 MODELS

These vehicles use the standard unit system (CU) with or without the air conditioning system (CU+AC).

1. Disconnect the negative battery cable and the throttle cable from the pulley. Discharge the air conditioning system (if equipped).
2. Using two hose clamps, attach one to the water valve inlet hose and the other to the heater core inlet hose, to pinch off the cooling system.
3. Disconnect the hose from the water valve.
4. From the left side of the dash, remove the lower panel. Remove the hose from the panel air vent.
5. At the control panel, move the selector to the FLOOR position. Place a rag below the water valve.
6. Remove the following items:
   a. The accelerator pedal.
   b. The ignition system control unit and bracket.
   c. The cruise control connector (if equipped).
   d. The water valve hose and the grommet.
7. Remove both hoses from the water valve and the clip from the water valve control cable.
8. To remove the water valve, turn it right, pull it out and disconnect the cable.
9. Remove the heater core cover and the heater core.
10. Install the heater core and the cover. Connect the water valve.
11. Install the water valve control cable clip, turn the valve left, adjust the cable and install the clip. Connect the hoses to the water valve and the heater core.
12. Install the following items:
    a. The grommet and the water valve.
    b. The cruise control connector (if equipped).
    c. The ignition system bracket and control unit.
    d. The accelerator pedal.
13. Connect the hose to the panel vent below the dash and the lower panel.
14. Connect the throttle cable to the pulley.
15. Refill the cooling system and recharge the air conditioning system (if equipped).
16. Start the vehicle, allow it to reach normal operating temperatures, check the system operation and for leaks.

760 AND 780 MODELS — WITHOUT ELECTRONIC CLIMATE CONTROL

See Figures 18, 19 and 20

➡The following procedure is for vehicles equipped with the Climate Unit (CU) and Automatic Climate Control (ACC) systems.

1. Disconnect the negative battery cable.
2. Drain the cooling system or pinch the heater hoses to prevent coolant from leaking when the core is removed.
3. Remove the ashtray, the ashtray holder, the cigarette lighter and console's storage compartment.

➡Two screws are located under the plastic cover.

4. Remove the console assembly from the gearshift lever and the parking brake.
5. Disconnect the electrical connector. Remove the rear ash tray, the console and light.
6. Remove the screws beneath the plastic cover in the bottom of the storage compartment and the parking brake console.
7. From the left side of the passenger compartment, remove the panel from under the dashboard.
8. Pull down the floor mat and remove the side panel screws, front and rear edges.

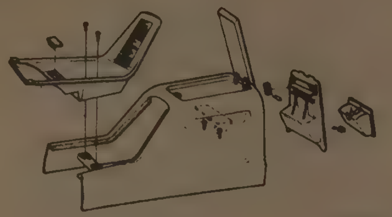

Fig. 18 Exploded view of the center console assembly — 760GLE models

9. From the right side of the passenger compartment, remove the panel from under the glove compartment and the glove compartment box with lighting.
10. Pull down the floor mat on the right side and remove the side panel screws, front and rear edge.
11. Remove the radio compartment screws.
12. Remove the screws from the heater control, the radio compartment console and the control panel.
13. Loosen the central electrical unit and remove the mount it from the dash.
14. Remove the center dash panel, the distribution duct screw and the air duct-to-panel vents/distribution duct screws.
15. Remove the screws holding the air ducts top-to-rear seats and the air distribution duct section-to-rear seat ducts.
16. Remove the vacuum hoses from the vacuum motors and the hose from the aspirator (if equipped with an ACC unit).
17. Remove the distribution unit from the vehicle.
18. Remove the retaining clips and the heater core assembly.
19. If the vacuum motors must be replaced, remove the panel from the distribution unit and replace the vacuum motor.
20. Install the heater core assembly and the retaining clips.
21. Install the distribution unit into the vehicle.
22. Connect the vacuum hoses to the vacuum motors and the hose to the aspirator (if equipped with an ACC unit).
23. Install the air ducts top-to-rear seats and the air distribution duct section-to-rear seat ducts.
24. Install the center dash panel, the distribution duct screw and the air duct-to-panel vents/distribution duct screws.
25. Install the central electrical unit and the mount to the dash.
26. Install the heater control, the radio compartment console and the control panel.
27. Install the radio compartment screws.
28. At the right side of the passenger compartment, install the panel under the glove compartment and the glove box.

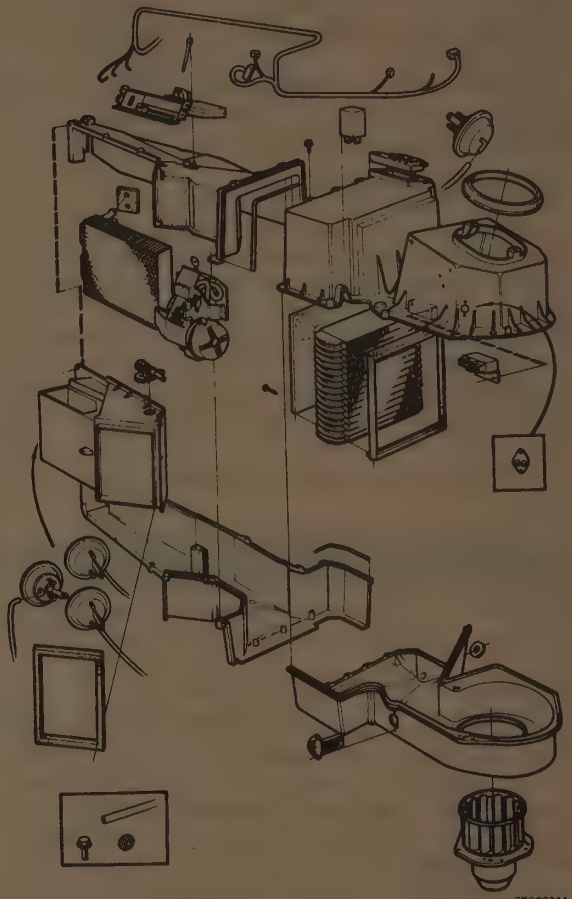

Fig. 19 Exploded view of the climate control unit with Automatic Climate Control — 760GLE

29. Install the side panel screws.
30. At the left side of the passenger compartment, install the panel under the dashboard.
31. Install the plastic cover in the bottom of the storage compartment and the parking brake console.
32. Connect the electrical connector. Install the rear ash tray, the console and light.
33. Install the console assembly to the gearshift lever and the parking brake.
34. Install the ashtray holder, the ashtray, the cigarette lighter and console's storage compartment.
35. Remove the heater hose clamps, refill the cooling system and charge the air conditioning system.
36. Connect the negative battery cable. Start the engine, allow it to reach normal operating temperatures, check the system operation and check the system for leaks.

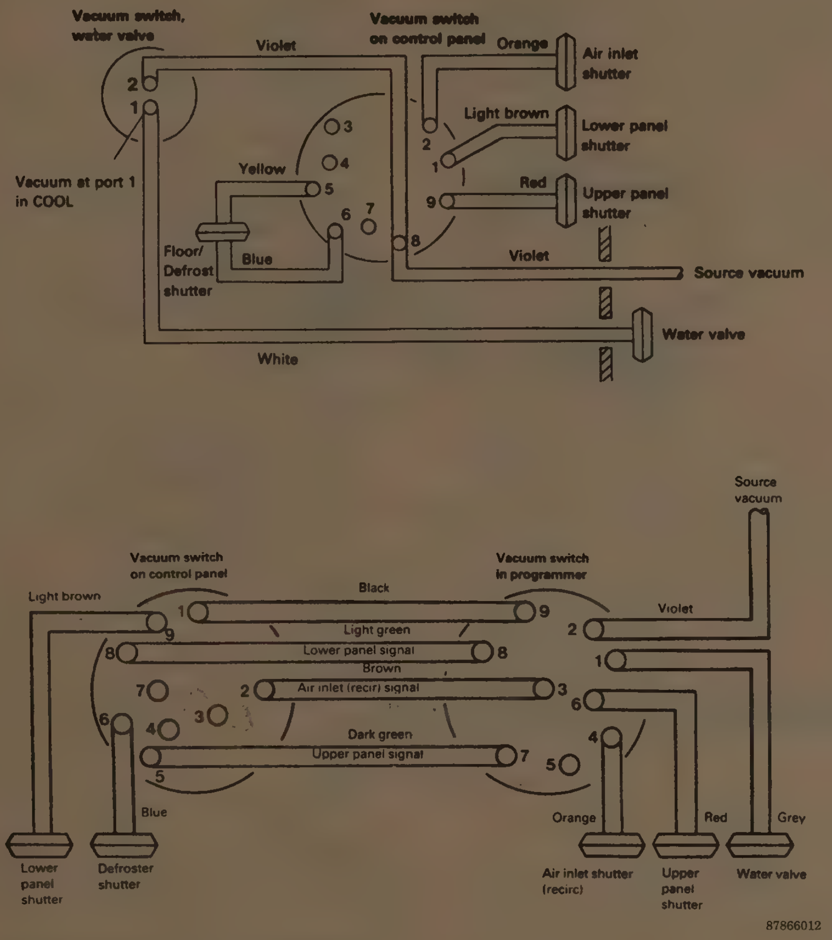
Vacuum switch, water valve
Violet
Vacuum switch on control panel
Orange
Air inlet shutter
Light brown
Lower panel shutter
Yellow
Red
Upper panel shutter
Vacuum at port 1 in COOL
Floor/ Defrost shutter
Blue
Violet
Source vacuum
Water valve
White
Source vacuum
Vacuum switch on control panel
Vacuum switch in programmer
Light brown
Black
Violet
Light green
Lower panel signal
Brown
Air inlet (recir) signal
Dark green
Upper panel signal
Blue
Orange
Red
Grey
Lower panel shutter
Defroster shutter
Air inlet shutter (recirc)
Upper panel shutter
Water valve
87866012

Fig. 20 Vacuum routing for CU and ACC systems. Upper: CU with A/C. Lower: ACC system

760 AND 780 MODELS — WITH ELECTRONIC CLIMATE CONTROL

See Figure 21

➡The following procedure is for vehicles equipped with the Electronic Climate Control (ECC) system. It requires removal of the complete dashboard. Do not attempt this repair if you are not at ease with such complicated, lengthy procedures.

✱✱CAUTION

If the vehicle is equipped with the SRS (air bag) system, observe all safety precautions outlined earlier in this section before beginning disassembly.

1. Disconnect the negative battery cable.
2. Using hose clamp tools, pinch off the heater hoses at the heater core and disconnect the hoses from the core. Remove the heater core cover plate.
3. Remove the dashboard by performing the following procedures:
    a. From the right side, remove the lower glove box panel, the glove box, the footwell panel and the windshield pillar (A-pillar) inner trim. Disconnect the solar sensor electrical connector and pull out the cable ties.
    b. From the left side, remove the lower steering wheel sound-proofing, the knee bolster (leave the bracket attached to the bolster), the footwell panel and the A-pillar panel.
    c. From the left side, remove the defroster grille, the plastic fusebox screws, the ashtray, the dashboard-to-center console screws, the parking brake-to-console screws (move console rearward) and the lower center console screws (located below the ashtray).

➡Before performing the next procedure, be sure the front wheels are in the straight ahead position.

d. If not an SRS vehicle, remove the steering wheel, the steering wheel adjustment assembly (Allen wrench), the upper steering column cover panels and the steering column combination switch assembly.

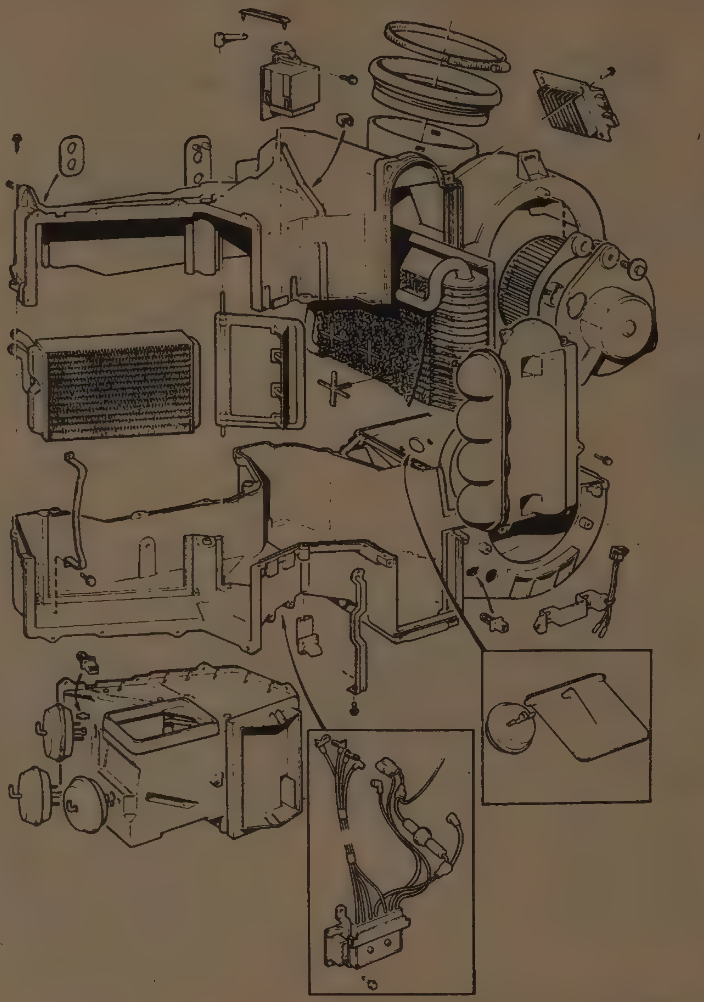

Fig. 21 Exploded view of the ECC system

e. If an SRS vehicle, remove the steering column adjuster (Allen wrench), the steering column covers, the air bag assembly (Torx head wrench), the steering wheel center bolt, the plastic tape label screw from the steering wheel hub (use the lock screw, label attached, to lock the contact reel through the steering wheel hub hole) and lift off the steering wheel. Remove the contact reel and the steering column combination switch assembly.

➡After securing the contact reel, do not turn the steering wheel for it will shear off the contact reel pin.

f. From the left side of the steering column, use fingers to push out the light switch panel. Remove the small trim mouldings and the light switch.

g. From the right side of the steering column, use fingers to push out the switch panel. Remove the ECC control panel, the radio console and the small trim moulding.

h. Remove the outer air vent grille by lifting it upwards, grasp it at the bottom and pull it upwards to release it. Remove the instrument panel cover-to-dash screws and the cover.

i. Remove the combined instrument assembly-to-dash screws (2 screws are next to the steering column) and the assembly; disconnect any electrical connectors and/or vacuum hoses.

j. From the rear of the dashboard, cut the cable ties.

k. At the dashboard-to-firewall area, turn the retaining clips ⅓ turn (to release), pull the dash out slightly and pass the fuse box through the opening. Disconnect the cable harnesses from the dashboard and carefully lift it from the vehicle.

4. Remove the lower duct from the left side of the heater/air conditioning housing. Disconnect the vacuum hoses from the diaphragms and the electrical connector. Remove the heater core cover-to-housing screws and the cover.

5. Remove the heater core-to-housing bracket and carefully remove the heater core.

6. Install the heater core and the bracket.

7. Install the heater core cover to the housing. Connect the electrical connector and the vacuum hoses. Install the lower duct to the housing assembly.

8. Install the dash by performing the following procedures:
   a. Install the dash, connect the cable harnesses, pass the fuse box through the opening. Secure the dash clips by turning them ⅓ turn.
   b. Install the combined instrument assembly to the dash. Install the instrument panel cover and the outer air vent grille.
   c. Install the small trim molding, the radio console, the ECC control panel and the right side switch panel.
   d. At the left side of the steering column, install the light switch, the small trim moldings and the light switch panel.
   e. If an SRS vehicle, install the steering column combination switch assembly and the contact reel. Install the steering wheel and remove the lock screw. Install the steering wheel center bolt, the air bag assembly and the steering column adjuster.
   f. If not an SRS vehicle, install the steering column combination switch assembly, the steering column covers, the steering wheel adjustment assembly and the steering wheel.
   g. At the left side, install the lower center console screw, the parking brake-to-console screws, the dashboard-to-center console screws, the ashtray, the plastic fusebox screws and the defroster grille.
   h. At the left side, install the A-pillar trim, the footwell panel, the knee bolster (with bracket) and the lower steering wheel sound-proofing.
   i. At the right side, connect the solar sensor electrical connector, install the A-pillar trim, the footwell panel, the glove box and the lower glove box panel.
9. Install the heater core cover plate and connect the heater hoses to the heater core.
10. Refill the cooling system. Connect the negative battery cable.
11. Start the engine, allow it to reach normal operating temperatures. Check the heater operation and the system for leaks.

Heater Controls and Control Panel

REMOVAL & INSTALLATION

While reasonably simple to remove, the control panel is connected to the various systems by a cluster of wires, cables and vacuum hoses. Use caution during removal and installation not to damage or crimp these items. Label items as they are disconnected. Work gently and don't force the panel into position; cables and linkages must move smoothly throughout their entire range of travel.

200 Series

➧ **See Figure 22**

1. Disconnect the negative lead to the battery.
2. Remove the soundproofing and and side panels on both sides of the center dash.
3. Remove the radio.
4. Loosen and remove the screws holding the control panel cover and move the cover aside.
5. Remove the control panel; carefully move it away from the dash as far as possible. Repairs or replacements can now be performed on the back of the control panel. If it is necessary to replace a lever assembly, note that the knob on the front pulls off, allowing the lever to slip through the slot. Any needed adjustments should be performed (to cables etc.) at this time.

To install:

6. Carefully refit the control panel to the dash.
7. Install the cover panel and secure it.
8. Reinstall the radio.
9. Install the soundproofing and side panels; reconnect the negative battery cable.

700 Series

➧ **See Figure 23**

1. Disconnect the negative battery cable.
2. Carefully remove the trim panel surrounding the heater controls. It will break if you force it.
3. Remove the four screws holding the controls to the dash; slide the unit free. Depending on whether the car has the CU, ACC or ECC system, the control unit will have a mass of cables and vacuum lines attached. Label every item you disconnect to ease reinstallation.
4. When reassembling, use care to prevent kinks in the vacuum hoses.

Evaporator Core

REMOVAL & INSTALLATION

The evaporator is made of aluminum and consists of chambers which are separated by fins. The refrigerant flowing into the evaporator, expands, boils and absorbs heat from the surrounding air. As a result, water condenses on the fins and is drained off through a hose at the bottom of the evaporator housing.

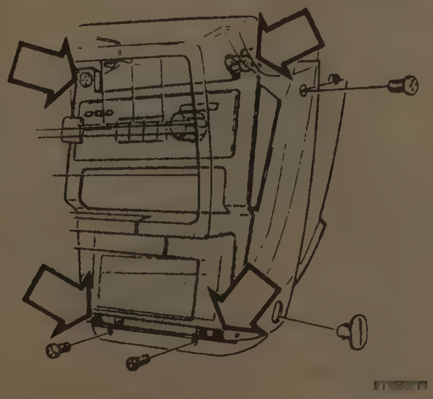

Fig. 22 Remove the screws indicated to loosen the heater control panel

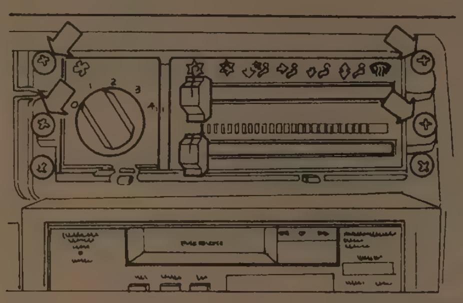

Fig. 23 Remove these four screws to detach the heater control — 700 series

200 Series

➧ **See Figure 24**

1. Following the instructions given above, remove the heater/air conditioning assembly from the vehicle.
2. Place the assembly on a cleared area and remove or disconnect the following:
    a. The upper hose from the heater core.
    b. The air inlet rubber seal from the top of the housing.
    c. The REC shutter clips from the left side.
    d. The rubber seals from both defroster vents.
    e. All clips from both the outer blower motor casings and remove the casings from the assembly.
3. Remove the blower wheel locking clips from both sides and the blower wheels.
4. Remove the heater core drain hose, the vacuum tank assembly, the vacuum tank bracket screws from the left side, the REC shutter spring and the heater housing clips.
5. Remove or disconnect the blower motor screws, the heater control valve capillary tube from the attachment and the vacuum hoses from the T-joint.
6. Carefully separate the heater/air conditioning housing at the center seam.
7. Remove the blower motor, evaporator and the heater core assembly.

To install:

8. Install the heater core, the evaporator and the blower motor.
9. Using sealant, coat the heater/air conditioning housing halves and assemble the housings.
10. Install or connect the vacuum hoses to the T-joint and the heater control valve capillary tube.
11. Install the heater/air conditioning housing clips, the REC shutter spring, the vacuum tank bracket, the vacuum tank and the heater core drain hose.
12. Install the blower motor wheels and the blower motor wheel clips to both sides.
13. Install or connect the following items:
    a. The clips to both the outer blower motor casings and the assembly casings.
    b. The rubber seals to both defroster vents.
    c. The REC shutter clips to the left side.
    d. The air inlet rubber seal to the top of the housing.
    e. The upper hose from the heater core.
14. Install the heater/air conditioning assembly into the vehicle.
15. Connect the evaporator lines to the evaporator, refill the cooling system and charge the air conditioning system.
16. Start the engine and check the system operation.

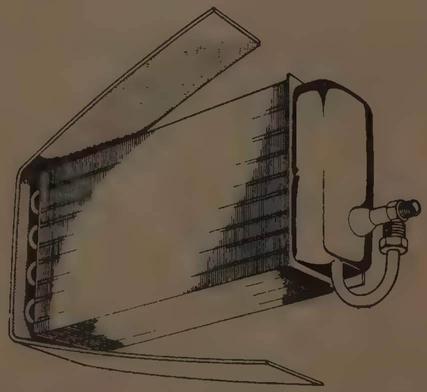

Fig. 24 A common air conditioning system evaporator — 240 model shown; others are similar. Always reinstall the protective cover

740 and 760 Models With Climate Unit (CU) and Automatic Climate Control (ACC)

1. Disconnect the negative battery cable and the throttle cable from the pulley. Safely discharge the refrigerant from the air conditioning system.
2. Disconnect, cap or plug the evaporator connections in the engine compartment.
3. Using 2 hose clamps, attach one to the water valve inlet hose and the other to the heater core inlet hose, pinching off the cooling system.
4. Disconnect the hose from the water valve.
5. Remove the lower panel from the left side of the dash. Remove the hose from the panel air vent.
6. At the control panel, move the selector to the FLOOR position.
7. Remove the following items:
    a. The accelerator pedal.
    b. The ignition system control unit and bracket.
    c. The cruise control connector (if equipped).
8. Remove the evaporator cover and the evaporator.
9. Install the evaporator and the cover.
10. Install the water valve control cable clip, turn the valve to the left (counterclockwise), adjust the cable and install the clip. Connect the hoses to the water valve and the heater core.
11. Install the following items:
    a. The cruise control connector (if equipped).
    b. The ignition system bracket and control unit.
    c. The accelerator pedal.
12. Connect the hose the panel vent below the dash and the lower panel.
13. Connect the throttle cable to the pulley.

14. Refill the cooling system and recharge the air conditioning system.
15. Start the vehicle, allow it to reach normal operating temperatures, check the system operation and for leaks.

760 and 780 Models With Electronic Climate Control (ECC)

1. Disconnect the negative battery cable.
2. Safely discharge the air conditioning system.
3. Disconnect the electrical connector and unscrew the receiver/drier from the wheel house.
4. Disconnect the electrical connectors from the firewall. Remove the cover plate and the foam rubber seal.
5. Remove the lower glove box panel and the glove box.
6. Disconnect the vacuum lines from the tank and remove the evaporator cover.
7. Carefully pull out the evaporator.
8. Carefully position the evaporator into the housing.
9. Install the evaporator cover and connect the vacuum lines to the tank.
10. Install the foam rubber seal and the cover plate at the firewall.
11. Connect the air conditioning lines and the vacuum lines.
12. Install and connect the receiver/drier at the wheel house.
13. Charge the air conditioning system.
14. Start the engine and check the operation of the air conditioning system.

ENTERTAINMENT SYSTEMS

Radio

REMOVAL & INSTALLATION

See Figures 25, 26, 27, 28, 29 and 30

Analog (Dial Type) Tuners — Pre-1980

1. Disconnect the negative battery cable.
2. Remove the radio control knobs by pulling them straight out. Remove the control shaft retaining nuts.
3. Disconnect the speaker wires, the power lead (either at the fuse box or at the in-line fuse connection), and the antenna cable from its jack on the radio.
4. Remove the hardware which attaches the radio to its mounting (support) bracket(s) and slide it back and down from the dash.
5. Reverse the above procedure to install. Don't overtighten the shaft nuts and make sure the wiring is firmly connected before reinstalling the radio unit.

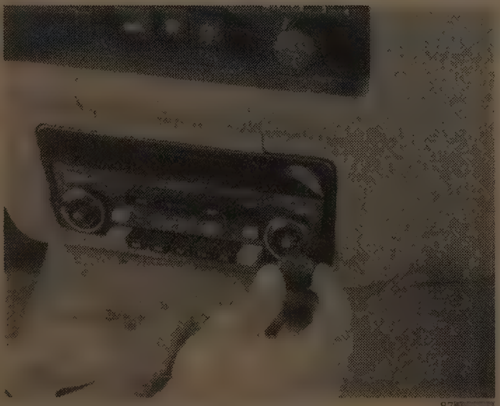
87

Fig. 25 Pull off all knobs and rings and organize them in a secure location so you can find them when it's time to reinstall

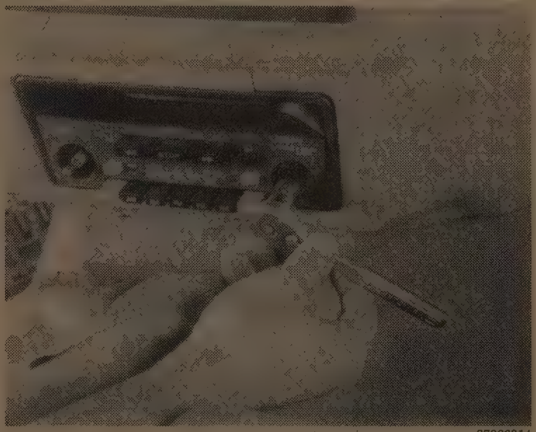
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Fig. 26 Use the correct size socket to remove the retaining nuts — when installing do not overtighten

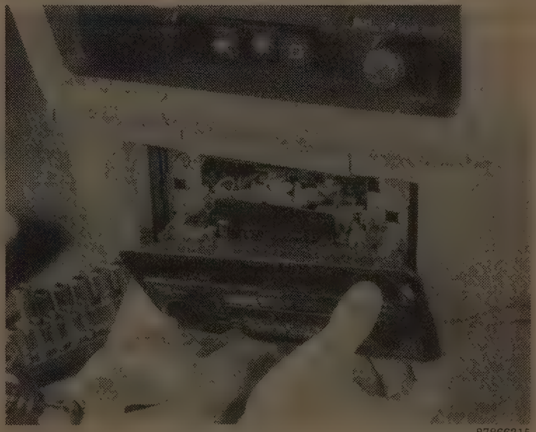
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Fig. 27 On this style of radio, once the retaining nuts are removed, the face plate is free

Digital Tuners — 1980 and Later

On most of the 200 series and some of the earliest 700 series, the radio is held in by two clips in the console. Re-

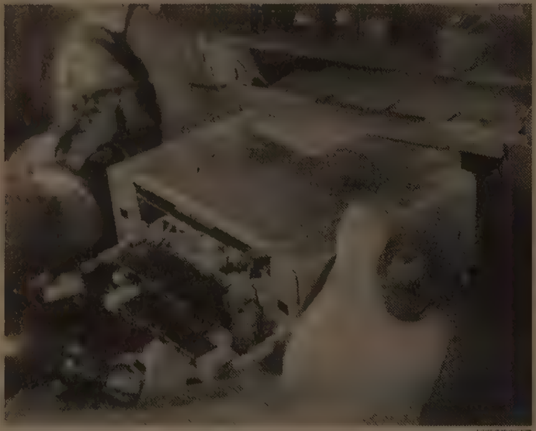

Fig. 29 Pull out the radio once it's detached just far enough to unplug the electrical connections in the back

move the side covers and locate the two access holes (one on each side) in line with the radio case. Insert a small probe or very small screwdriver into each hole and push gently. This releases the clip and the radio may be removed from the front of the console.

Later models have the same style clips, but they are released by inserting a thin, flat probe down each side of the radio from the front. Again, release the clips and slide the radio free. Disconnect the wiring before pulling the radio too far from the dash.

The newest radios are the easiest to remove, with the releases being built into the front of the case. Simply push the tabs with your fingers and remove the radio.

**WARNING

Although these radios are the simplest to remove, many have a security code programmed into the circuitry. Once reinstalled, the radio will not work if the correct code is not entered. The radio should not be removed or disconnected if the user code is not available.

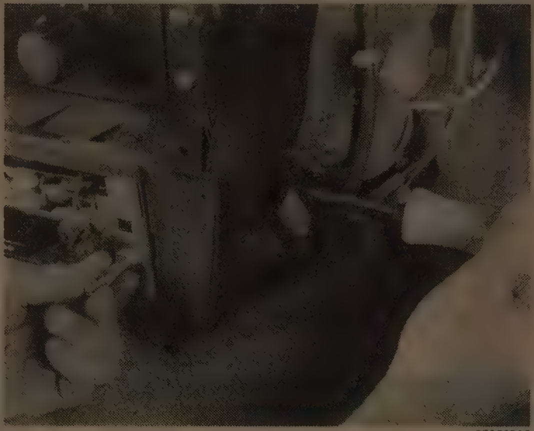

Fig. 28 Some radios require the console to be removed in order to unscrew the radio from the sides

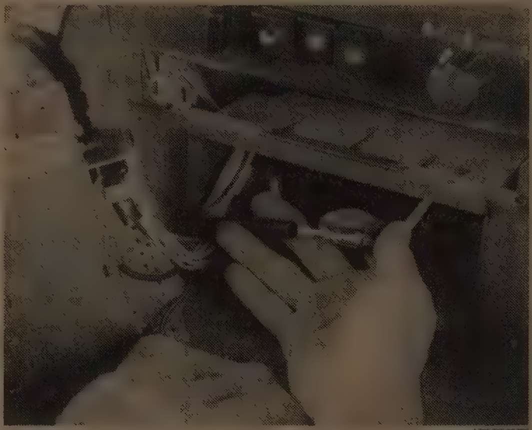

Fig. 30 Disconnect all wires and the antenna, then remove the radio

WINDSHIELD WIPERS

Windshield Wiper Blade

REMOVAL & INSTALLATION

1970-83 Models

➧ See Figure 31

1. Lift the arm and blade clear of the glass.
2. Press in the locking tab on the back of the wiper arm.
3. Remove the blade assembly from the arm. A little side to side motion can help to loosen the blade assembly.
4. When reinstalling, make sure the new blade seats on the arm with a distinct click. If it doesn't click, it isn't on properly and will fly off later.

1984-89 Models

➧ See Figure 32

1. Lift the wiper arm and blade clear of the glass. Hold the blade assembly at right angles to the arm.
2. Pinch in the end of the plastic clip at the back of the arm.
3. Slide the blade assembly down the arm until it clears the "U" at the end.
4. Move the blade slightly to the side and remove it from the arm.
5. When reinstalling, pay attention! It is possible to get the blade on the arm backwards, resulting in strange positioning against the glass. The blade should seat on the arm with a distinct click and should then be able to be folded down paral-

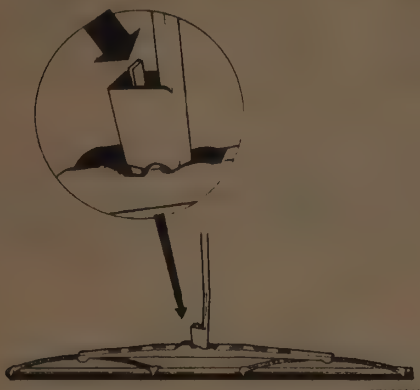

Fig. 31 Replace the wipers as shown — models through 1983

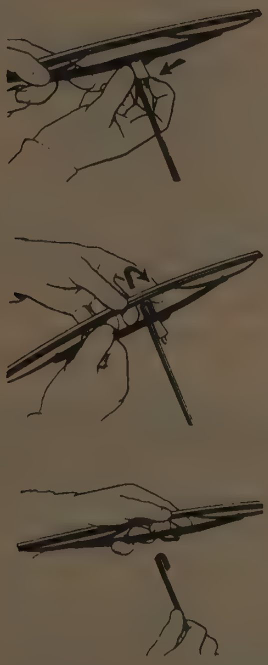

Fig. 32 Replace the wiper blades as shown — 1984 and later

lel to the arm so that it sits flush against the glass over its entire length.

Windshield Wiper Arms

REMOVAL & INSTALLATION

All Models

➧ See Figures 33, 34 and 35

1. Pry up or lift the plastic or metal spindle cover at the base of the arm.
2. Unscrew and remove the axle nut.
3. Gently lift the blade and arm from the glass and remove the arm from the drive axle.
4. When reassembling, tighten the axle nut to 10-13 ft. lbs. (14-19 Nm). Do not overtighten or the splines will be dam-

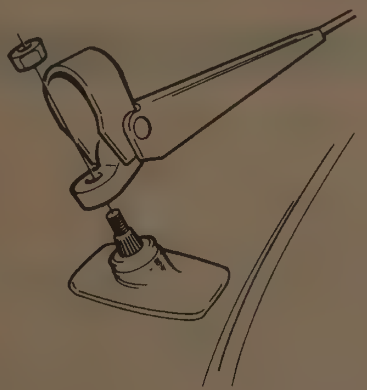

Fig. 33 Lift the cover for access to the wiper axle nut

Fig. 34 Lift the plastic cover, then use the correct metric wrench (or socket) to remove the nut

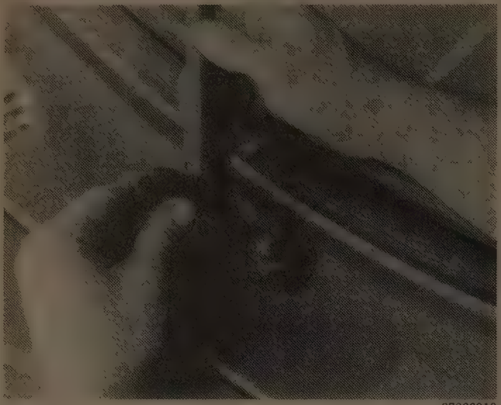

Fig. 35 Lift the blade from the glass, then remove the arm which is lightly pressed onto the tapered splines of the drive axle

aged. Make sure the the wiper blade will be in the correct position on the glass before tightening the nut.

Windshield Wiper Motor

REMOVAL & INSTALLATION

1800 Series — Complete Windshield Wiper Unit

1. Disconnect the negative battery cable.
2. Remove the wiper arm and blade assemblies. Unscrew the wiper arm shaft nuts and lift off the washers and rubber seals.
3. Disconnect the electrical wires at the wiper motor.
4. Remove the two wiper motor retaining bolts and lower the motor and linkage assembly out from under the dash.
5. Reverse the above procedure to install.

1970-72 140 Series and 164 Models

1. Disconnect the negative battery cable.
2. Remove the wiper arm and blade assemblies.
3. Remove the molded panel from under the dash.
4. Remove the heater switch.
5. Remove the instrument cluster as outlined in Instrument Cluster Removal and Installation.
6. Remove the intermediate defroster nozzle and disconnect the hoses.
7. Remove the retaining bolts and lower the wiper motor.
8. Install the motor and secure the retaining bolts.
9. Replace the defroster nozzle and connect its hoses.
10. Reinstall the instrument cluster.
11. Install the heater switch and the molded panel below the dash.
12. Reinstall the wiper arm and blade assemblies, making sure that the blades will be correctly positioned on the glass.

1973-75 140 Series, 164 Models and 240 Series

➧ See Figures 36, 37 and 38

1. Disconnect the negative battery cable.
2. Disconnect the drive link from the wiper motor lever by unsnapping the locking tab underneath the dashboard.
3. Open the hood and disconnect the plug contact from the motor, located on the firewall.
4. Remove the three attaching screws and lift out the motor.

To install:

5. When reinstalling,take care to transfer the rubber seal, rubber damper, and spacer sleeves to the new motor. Position the motor and secure its mounting screws. Connect the plug.
6. Under the dash, connect the drive link and make sure it is locked in place.
7. Reconnect the negative battery cable.

All 1976 and Later 200 Series Models

➧ See Figure 39

➡This procedure includes wiper drive link removal and installation.

1. Disconnect the negative battery cable.
2. Remove the right side-panel and remove the panel under the dashboard (beneath the glove box).
3. Remove the defroster hoses and remove the glove box.
4. Remove the wiper arms.
5. Disconnect the wiper assembly and lift it out through the glove box opening.
6. Reverse the above procedure to install.

700 Series

➧ See Figure 40

1. Disconnect the negative battery cable
2. Remove the wiper arms and remove the rubber boot at the base of the arm.
3. Lift the hood to its uppermost position by pushing the catch on the hood hinges.
4. Release the washer hoses from the clips along the edge of the cowl. Unscrew the cowl retaining bolts. Older cars may use plastic clips instead of bolts to hold the cowl in place. Lower the hood to its normal position.
5. Remove the cowl by pulling it forward and then rotating the front edge upward. Close the hood.
6. Unscrew the bolts which hold the linkage assembly. One of the bolts is hidden beneath a rubber cap.
7. Remove the cover from the wiper motor, cut the cable tie and disconnect the plug to the motor.
8. Unscrew the spindle nut on the motor and the three bolts holding the motor to the linkage. Lift the motor free of the linkage.

To install:

9. When reassembling, make sure the wipers are in the park position.
10. After the motor is secure on the linkage and the linkage is mounted on the car, visually check for any possible interference between the moving parts and the wiring. Always reinstall the wire tie on the motor harness.
11. Make sure the cowl is properly seated before installing the bolts. Install the washer hoses in their clips, replace the rubber boots and install the wiper arms. Connect the negative battery cable.

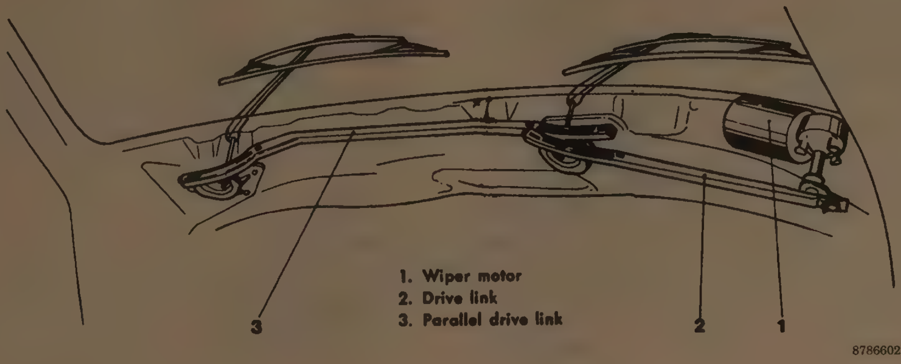
1. Wiper motor
2. Drive link
3. Parallel drive link
3
2
1
87866020

Fig. 36 Details of the windshield wiper assembly — 1973-75 140 series, 164 models and 240 Series

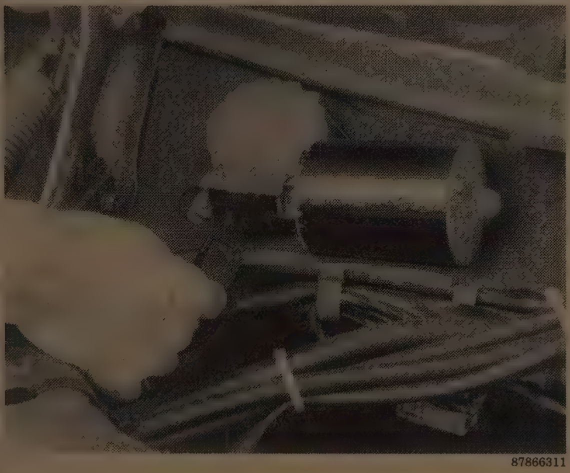

Fig. 37 Unplug the electrical connector from the motor

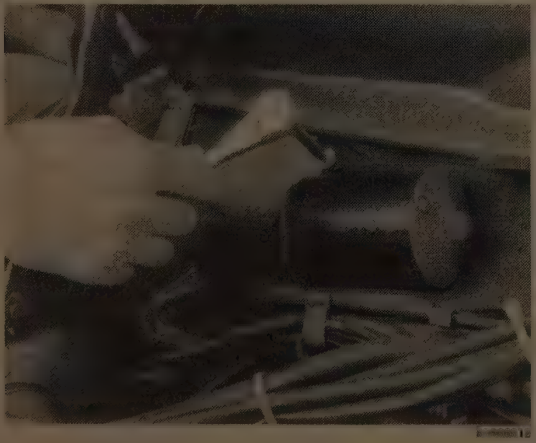

Fig. 38 Remove the three attaching screws and lift out the motor

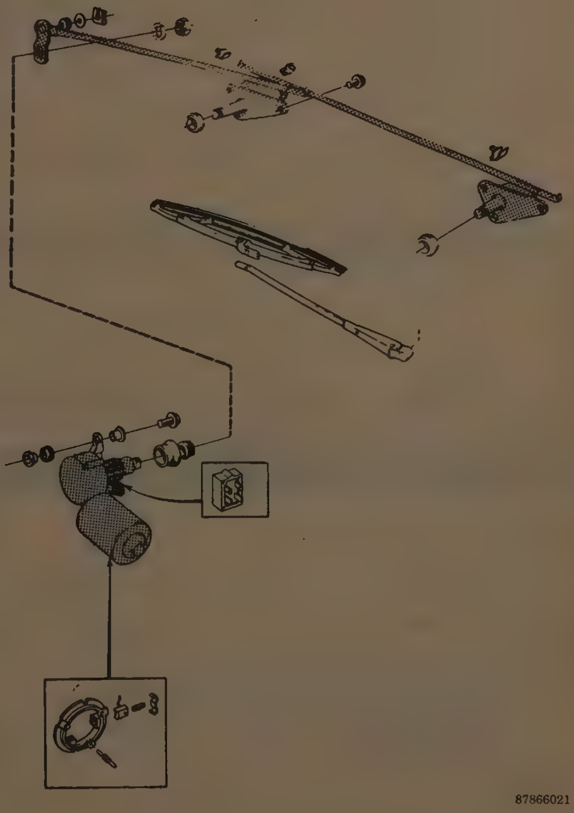

Fig. 39 Exploded view of the windshield wiper assembly — 1976 and later except GLE

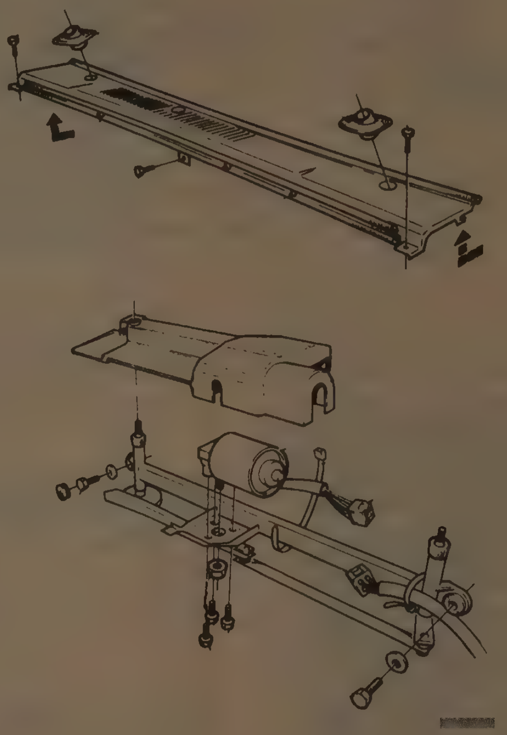

Fig. 40 Exploded view of the wiper linkage assembly (mounted beneath the cowling) — 700 series

Wiper Linkage

REMOVAL & INSTALLATION

1970-72 140 Series and 164

1. Disconnect the negative battery cable.
2. Remove the wiper motor as described above.
3. Disconnect the heater control cable.
4. Remove the fuse box from its bracket and allow it to hang free.
5. On carbureted versions, remove the choke cable.
6. Remove the attaching screws for the wiper frame and lower the frame.
7. Reverse the above procedures to install.

1974-75 140 Series, 164 Models and 240 series

DRIVE LINK

1. On vehicles equipped with a combination heater-air conditioner unit, remove the glovebox and the right defroster nozzle.
2. Remove the right side panel and the defroster hoses.
3. Remove the locking tab for the wiper motor lever connection, loosen the nut for the cable stretcher, and remove the drive link.
4. When reassembling, carefully place the cable around the wiper arm drive segment. Make sure the cable nipple is inserted in the recess.

PARALLEL DRIVE LINK

1. On vehicles equipped with a combination heater-air conditioner unit, remove the glovebox and the right defroster nozzle.
2. Remove the right-hand side panel and the defroster hoses.

3. Remove the drive link by releasing the locking tab for the wiper motor lever connection and loosening the cable stretcher.
4. Remove each cable stretcher nut and disconnect both ends of the cable from their wiper arm drive segments.
5. Lift forward and remove the parallel drive link.
6. Reverse the above procedure to install, taking care to place each cable end around its wiper drive arm segment. The cable nipple must be inserted in the segment recess.

CABLE

1. Remove the drive link and parallel drive link as described above.
2. Pry up and remove the cable retaining lockwasher. Remove the old cable.
3. Position the new cable on its wiper arm drive segments and secure it with a new retaining lockwasher.
4. Install the cable stretcher on the drive link. The tensioning nut should not be tightened until the drive link and parallel drive link are installed.
5. Install the drive link and parallel drive link. Tighten the tensioning nut.

Rear Windshield Wiper

REMOVAL & INSTALLATION

200 Series

➧ See Figure 41

1. Disconnect the negative battery cable.
2. Remove the upholstered finish panel on the inside of the tailgate.
3. Remove the bolts for the wiper motor protection plate.
4. Disconnect the ball-and-socket wiper arm link at the motor.
5. Fold the protection plate aside and lift out the wiper motor.
6. Mark the wires and disconnect them at the motor.

To install:

➡The brushes in the motor are replaceable. Remove the motor cover, unhook the brush springs and remove the brushes from the holders. Be careful not to damage the brush holders. Install the new brushes and attach the springs.

7. When reinstalling, make certain that the motor is in the park position before installing. Connect the wiring to the motor and install the motor and the protection plate.
8. Reattach the connecting link to the motor and install the retaining screws for the protection plate.
9. Install the trim panel on the inside of the tailgate and connect the negative battery cable.

700 Series

➧ See Figure 42

1. Disconnect negative battery cable.
2. Remove the inner trim pad on the tailgate.
3. Loosen and remove the center nut on the motor and remove the linkage from the motor.
4. Remove the bolts holding the motor and remove the motor. Disconnect the wiring from the motor.

To install:

5. When reassembling, make certain that the motor is in the park position.
6. Attach the wiring and mount the motor to the door.
7. Attach the linkage to the motor and tighten the center nut.
8. Replace the trim pad and attach the negative battery cable.

Headlight Wiper Blades

REMOVAL & INSTALLATION

➧ See Figure 43

The small blades for the headlight wipers found on the 700 Series are removed in the same fashion as the windshield

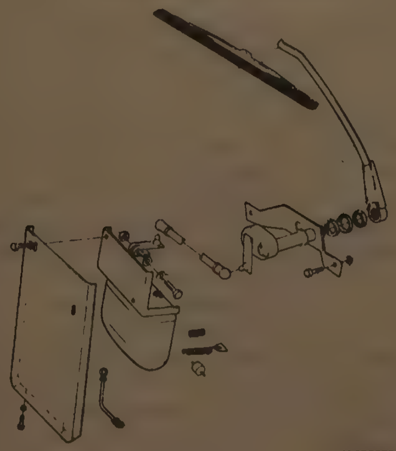

Fig. 41 Rear wiper assembly — 200 series

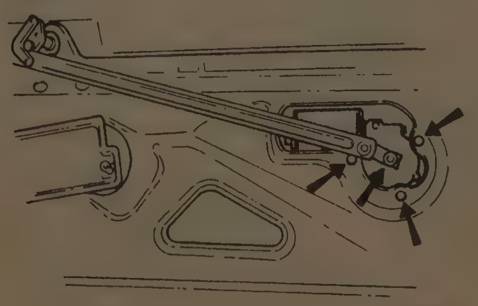

Fig. 42 Remove the fasteners shown to detach the rear wiper motor — 700 series

wiper blades. Pull the wiper away from the light, lift the spindle cover, unfasten the shaft nut, then remove the blade and arm. It is necessary to disconnect the washer tube from the blade assembly when removing the arm.

During installation, place the wiper blade below the park stop on the light. Tighten the shaft nut and reposition the blade above the stop. The blade should rest firmly on the stop. Don't forget to reattach the washer line.

Headlight Wiper Motor

REMOVAL & INSTALLATION

740 and 760 Models

➧ See Figure 44

1. Remove the wiper arm.
2. Disconnect wiring connector and the ground wire (2 separate connectors) for the motor. Connectors for both left and right motors may be located near the left fender
3. Loosen the nut on the motor shaft, slide off the plastic tubing and remove the motor.
4. Reassemble in reverse order. Make sure the motor is in the park position before installation. Insure a secure fit on all wiring connectors.

780 Models

1. Remove the wiper arm.
2. Disconnect wiring connector and the ground wire (2 separate connectors) for the motor. Connectors for both left and right motors may be located near the left fender.
3. Pull the wiring through the grommet in the front side panel.

For the LEFT wiper motor:

4. Remove the foglight or auxiliary light cluster and turn aside.
5. Loosen the nut on the motor shaft, remove the plastic tubing, and remove the motor through the front side panel.

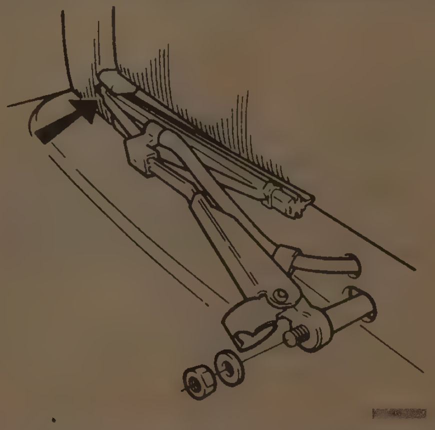

Fig. 43 Headlight wiper system — blade stop is shown by the arrow

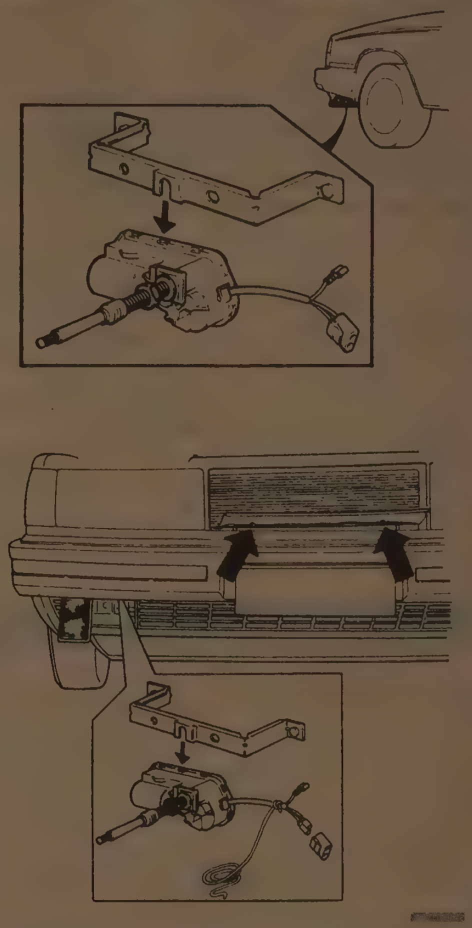

Fig. 44 Above: 740 and 760 models. Below: right side of 780. The wiper motor assembly mounts as shown. Arrows indicate wiring harness clips to be released for removal

6. Reassemble in reverse order. Make sure the motor is in the park position before installation. Insure a secure fit on all wiring connectors.

For the RIGHT wiper motor:

7. Tie a five foot piece of string to the wiring connectors. This will ease reinstallation.
8. Remove the grille.
9. Carefully lift the lower part of the spoiler and release the two clips holding the wiring harness.
10. Pull the wiring through the front of the spoiler, allowing the string to follow the wire path. When the wiring is clear of the spoiler, untie the string but allow it to remain in place in the car.
11. Remove the foglight or auxiliary light cluster and turn aside.
12. Loosen the nut on the motor shaft, remove the plastic tubing, and remove the motor.
13. When reassembling, remove the sleeves from the terminals of the new motor.
14. Install the motor and tie the string to the wiring harness. Position and attach the foglight assembly.

15. Using the string, pull the wiring through the spoiler and into position. Install new cable ties and/or clips as necessary; the cables and pipes across the front of the car must be held in place.

16. Reinstall the grille.

17. Remove the string and connect the electrical connectors, making sure they are clean and tight. Reinstall the wiper arm.

INSTRUMENTS AND SWITCHES

Instrument Cluster

REMOVAL & INSTALLATION

A voltage stabilizer feeds a 10 V current to both the temperature gauges and the fuel gauge. Electrical malfunctions in these gauges must be checked with an ohmmeter, not a 12 V test light. If malfunctions occur simultaneously in all three of the gauges that are fed by the stabilizer, the stabilizer itself is probably malfunctioning. When replacing the voltage stabilizer, the new unit must fit in the same position as the old one. If the stabilizer is not located correctly in the dash, the voltage output may be altered.

1800 Series

The 1800 series Volvos are equipped with a tachometer, coolant temperature gauge, oil temperature gauge, speedometer (with odometer, tripmeter, and warning lamps), fuel gauge, oil pressure gauge, and clock. Each of these instruments must be removed separately.

When replacing an instrument, first disconnect the negative battery cable, then disconnect the electrical connectors at the back of the gauge. Remove the retaining nuts and attaching bracket and pull the instrument straight out of the dash.

1970-72 140 Series and 164 Models

1. Disconnect the negative battery cable.
2. Remove the two screws holding the control panel.
3. Remove the two retaining screws and lower the molded panel beneath the dashboard.
4. Pull the upper section of the cluster outward so it loosens from its retaining clips. Loosen the panel from the hood release mechanism.
5. Move the control panel--with the short side first--through the dashboard opening.
6. Disconnect the heater controls and the speedometer cable. Remove the flange nuts for the instruments.
7. Rotate the instrument cluster slightly, so that the electrical connections may be removed from the back.
8. Lift out the cluster from the dashboard.

To install:

9. When reinstalling, remember to hook up the electrical connections before placing the unit into the dash.
10. Secure the flange nuts on the instruments and reconnect the speedometer and heater control cables.
11. Place the panel through the dash opening and engage the retaining clips.
12. Replace the molded panel under the dash, install the retaining screws for the instrument cluster and connect the negative battery cable.

200 Series

➧ See Figures 45, 46, 47 and 48

1. Disconnect the negative battery cable.
2. Remove the molded plastic casings from the steering column.
3. Remove the bracket retaining screw and lower the bracket toward the steering column.
4. Remove the cluster attaching screws. If necessary, remove any component controls to the right or left of the cluster to access the front-mounted retaining screws. Otherwise, unscrew from behind the cluster.
5. Disconnect the speedometer cable.

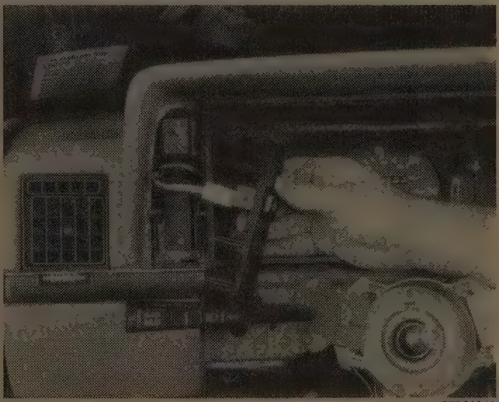

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Fig. 45 Remove the knobs, pry out the small left-side panel to access the instrument cluster mounting screws — 1985 240 series models shown

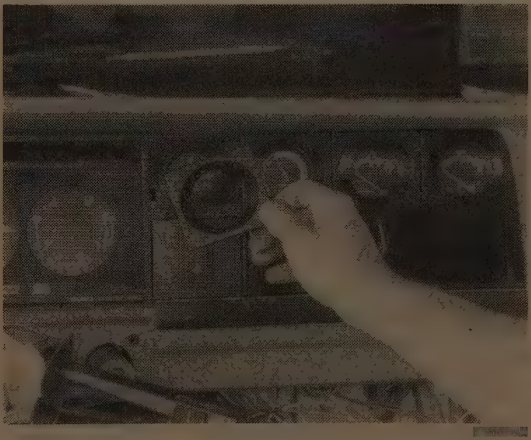

Fig. 46 Remove the trim ring and panel to the right of the instrument cluster to access the mounting screws

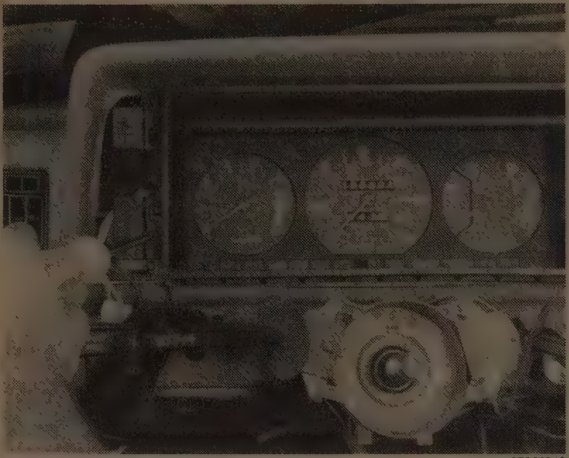

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Fig. 47 Unscrew the cluster to allow removal

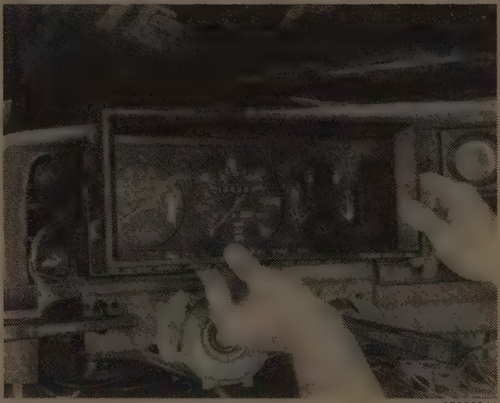

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Fig. 48 Carefully pull out the instrument panel. Don't force it if it sticks, but instead check to see if you left anything still fastened

6. Tilt the cluster out of its snap fitting and disconnect the plug. On vehicles equipped with a tachometer, disconnect the tachometer sending wire.
7. Lift the cluster out of the dashboard.

To install:

8. When reinstalling, make sure wiring and speedometer cable is reconnected before replacing the cluster. Also make sure the cluster engages its snap fittings when placed in the dash.
9. Install the cluster attaching screws and replace the bracket and retaining screw.
10. Install the molded plastic casings on the steering column and connect the negative battery cable.

700 Series

➧ See Figure 49

1. Remove the soundproofing above the foot pedals.
2. Remove the two cover panels and screws holding the instrument panel.
3. On 1982-86 and some 1987 models, cut the cable tie next to the air duct.
4. Lift the instrument cluster away from the dashboard.
5. Remove the connector seal on the back of the cluster and remove the electrical connectors.

To install:

6. When reinstalling, remember to hook up all the wiring before installation. Always use a new connector seal.
7. If the wiring harness was cut away from the air duct (step 3, above) always re-tie it to prevent chafing. Use a new wire tie and anchor securely.
8. Install the two retaining screws and replace the covers.
9. Install the soundproofing panel.

Speedometer Cable

REMOVAL & INSTALLATION

➧ See Figures 50, 51 and 52

On all cars through the 200 series, the speedometer is cable driven by the transmission. The cable is connected to a drive gear in the transmission case and connects to the dashboard unit which converts the number of cable revolutions into an expression of speed and distance.

The speedometer cable is unscrewed from the rear of the speedometer (it may be necessary to remove the instrument cluster for access) and from the transmission case. When installing a new cable, seat the ends of the inner cable in both the speedometer and transmission. Cable routing is critical; at no point should the bends in the cable be any sharper than a 4 inch radius. A crimped or binding cable can cause noise, vibration and possible damage to the speedometer unit.

➡A tamper-proof seal is installed on all 1977 and later models, on both the speedometer connection and the transmission connection. The speedometer connection has a plastic collar which must be broken to remove the cable. The retaining bolt for the transmission side of the cable is covered by a plastic cap which must be broken in order to remove the bolt.

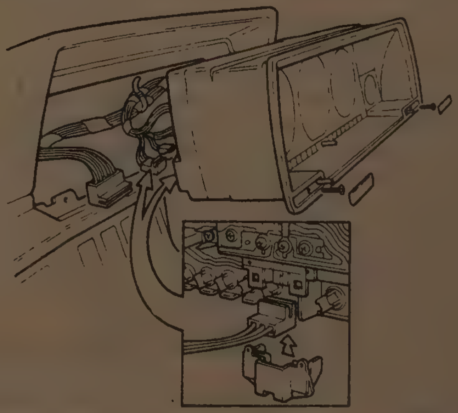

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Fig. 49 700 series instrument cluster mounting — note small screws under cover panels

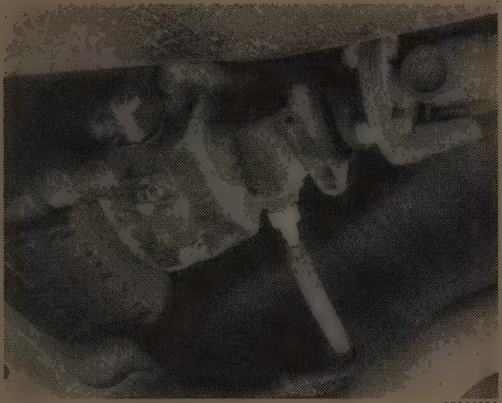

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Fig. 50 If replacement of the speedometer cable is necessary, it is located on the transmission case and will require you to raise and safely support the vehicle

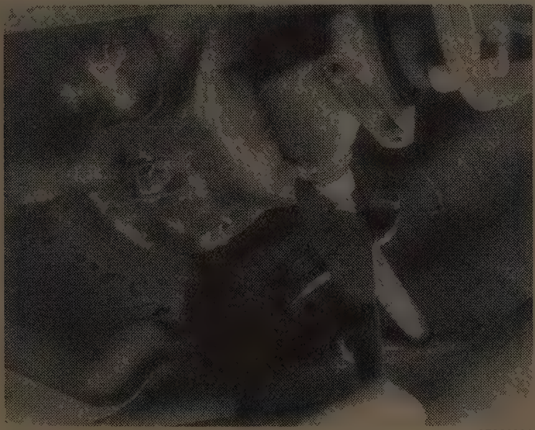

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Fig. 51 Use pliers to grip and turn the speedometer cable fitting

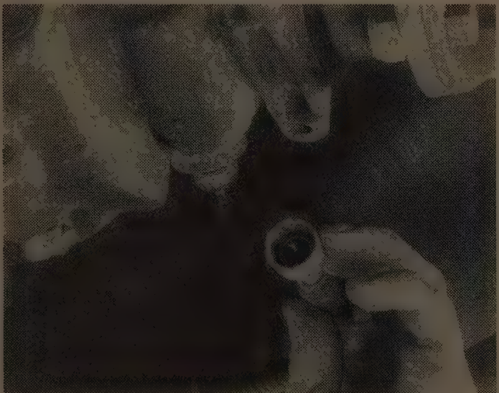

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Fig. 52 Make sure the cable is properly seated (male-to-female) prior to fully tightening the cable — do not kink less than a 4 inch bend

The 700 series does not have a mechanical cable. This series uses an electric inductive pick-up in the differential to generate speed data. The number of electrical pulses varies with the speed; the speedometer unit transforms the pulses into a readable display of speed.

An inoperative speedometer in these cars is really an electrical problem requiring the usual checking of fuses, grounds, connectors and wiring. The sensor mounted in the differential works on a critical internal clearance; it should not be removed or loosened for testing.

Windshield Wiper Switch/Turn Signal Switch

REMOVAL & INSTALLATION

See Figure 53

CAUTION

This procedure requires removal of the steering wheel. If the vehicle is equipped with the SRS (air bag) system, refer to the safety precautions listed earlier in this section. DO NOT remove the wheel until these precautions have been followed.

1. Turn the steering wheel to the straight ahead position.
2. Remove the center pad from the wheel.
3. Remove the steering wheel retaining bolt. If possible, matchmark the wheel and steering shaft. If the vehicle is equipped with SRS, pull out the locking screw and the long tape label from its station in the steering wheel hub. Use the lock screw (with the tape flag attached) to lock the contact reel through the hole in the steering wheel hub. Do not turn the steering wheel once the bolt is removed; the pin in the contact reel will shear.
4. Remove the steering wheel and the upper and lower steering column casings.
5. To remove the wiper switch, simply remove the screws holding it to the column and unplug the connector. The turn

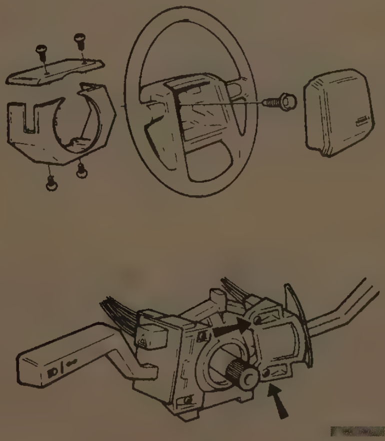

Fig. 53 Remove the steering wheel to access the wiper/turn signal switches — Non-SRS 700 series shown

signal switch is on the opposite side and is also held to the column by two or three screws.

To install:

6. When reassembling, remember to check the position of all the wires so that nothing is pinched in casings.
7. Reinstall the column casings and then reinstall the steering wheel. Check that the steering wheel position is true to the position of the wheels. If the vehicle is SRS equipped, do not turn the steering wheel until the center bolt is reinstalled and tight; doing so will shear the pin in the contact reel. Remove the locking bolt with its flag and store it in the extra hole on the left side of the wheel.
8. Tighten the steering wheel bolt to 24 ft. lbs. (32 Nm). Reinstall the center pad.
9. If equipped with the SRS system, make the necessary connections to reactivate the system.

Rear Window Wiper Switch

The tailgate washer/wiper controls are mounted on the same control stalk as the front wipers. The components are not individually replaceable for the rear system. To replace the switch assembly, follow the directions given for Windshield Wiper Switch, Removal and Installation.

Headlight Switch (Lighting Selector)

REMOVAL & INSTALLATION

Except 700 Series

1. Disconnect the negative battery cable.
2. Disconnect the hose from the left side dash vent.
3. Carefully remove the trim below the vent, remove the screws holding the vent in place and remove the vent assembly.
4. Using a very small screwdriver, loosen the set-screw holding the selector knob onto the shaft. If no set screw is evident, simply pull on the knob until it comes free of the shaft.
5. Remove the shaft nut from the switch and remove the switch through the back of the dash. Remove the plug from the back of the switch assembly.
6. When reassembling, remember to connect the new switch to the wiring harness and remember to tighten the small setscrew holding the knob to the shaft. Reconnect the battery and check the switch function.

700 Series

➧ See Figure 54

1. Remove the selector knob by pulling it free of the shaft.
2. Disconnect the wiring connector by reaching under the dash. It may be necessary to loosen or remove the under dash pad to gain access.
3. Remove the shaft nut from the switch and remove the switch through the back of the dash.
4. Reassemble in reverse order.

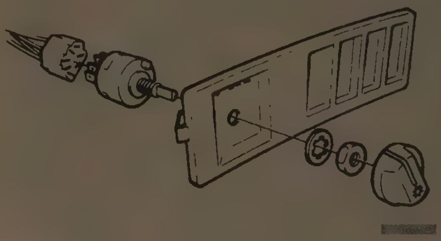

Fig. 54 Exploded view of the headlight selector switch — 700 series

Panel Mounted Switches

REMOVAL & INSTALLATION

➧ See Figures 55, 56, 57, 58 and 59

The dash or console mounted rocker switches are easily removed. Depending on the model, it may be necessary to remove the trim panel surrounding the switch. After this is done, reach behind the switch and disconnect the wire harness running to the switch. While your hand is back there, grasp each side of the switch, compress the retaining clips and remove the switch through the front of the panel.

Some switches, such as the air conditioning control on certain models, may consist of a knob retained by a nut. Use a socket to remove the switch panel from the switch panel, then disconnect and remove the switch from behind the panel.

If length allows, the wire harness may be brought out through the panel (after the switch is removed) for circuit testing. When reinstalling, make sure the wiring is properly routed

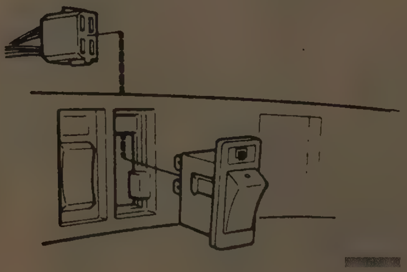

Fig. 55 The rocker switch mounts and is connected as shown

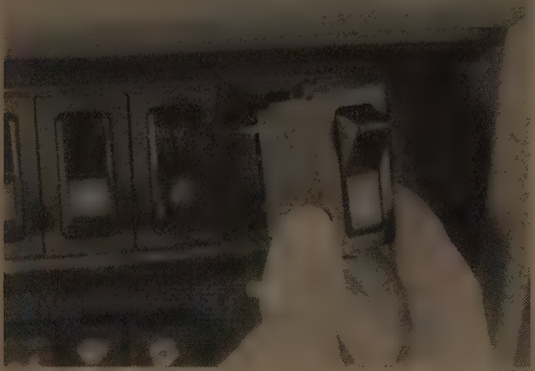
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Fig. 56 Remove the rocker switch, then unplug its electrical connection from behind

and not crimped or pinched. The switch should engage the panel with a definite click when in place. Reinstall the trim panel.

Ignition Switch

REMOVAL & INSTALLATION

➧ See Figure 60

On all models, the ignition keylock is mounted on the steering column and incorporates a steering wheel lock to deter car theft. The lock is attached to the steering column by shearbolts, which have heads that were broken off when they were tightened to the proper torque specification at the factory. Removing the lock requires removing these bolts, either by cutting slots in their tops and using a screwdriver to extract them, or by drilling them out. If they are drilled out, the lock housing will probably be damaged. On many models, removing the ignition lock also requires loosening or removing the steering column. Because of the complexity of these operations, repairs are best left to a professional repair facility.

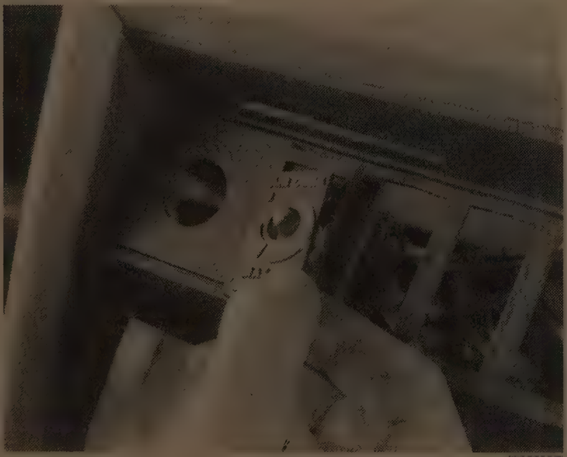

Fig. 57 Remove the label to access the retaining nut

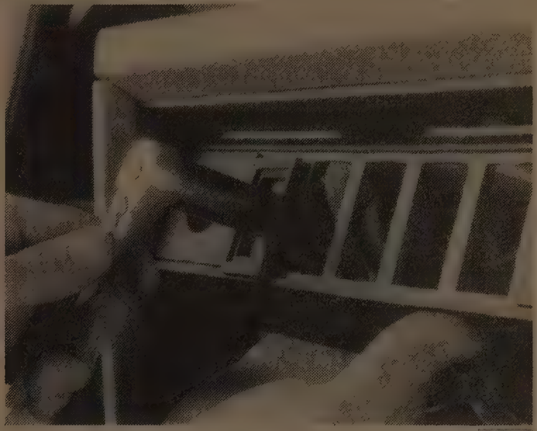

Fig. 58 Use a ratchet and socket to remove the nut retaining the switch

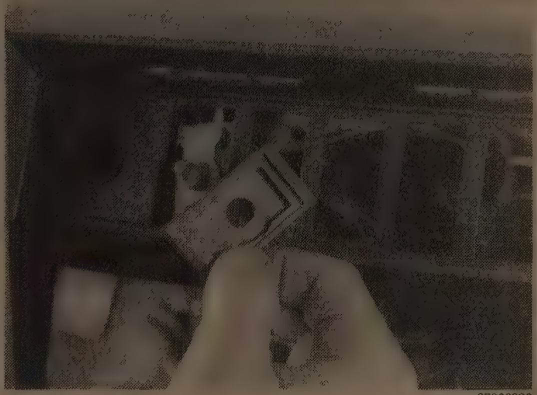
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Fig. 59 Set aside the trim piece, then disconnect and remove the switch from behind the panel

If your diagnosis of an electrical problem shows a failed ignition switch, the electrical part at the rear of the assembly can be changed on all 1975 and later models.

✻✻CAUTION

If the vehicle is equipped with the SRS (air bag) system, refer to the safety precautions listed earlier in this section.

Disconnect the negative battery cable and gain access to the back of the ignition switch by removing panels and covers as necessary. Remove the round multi-wire connector at the back of the switch, then unfasten and remove the electrical unit (sometimes called the start contact) from the back of the lock assembly.

This unit is generally held on with two small screws, but they are in a difficult location and an awkward position--have patience. When reassembling, make certain that the new unit is properly seated against the pin from the ignition lock. Also

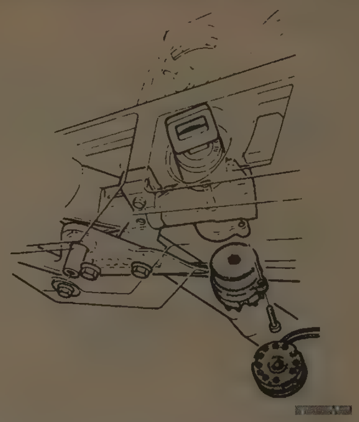

Fig. 60 The electrical contacts on the back of the ignition are replaceable — 700 series shown, others are similar

insure that the wiring connector is firmly attached to the new start contact.

With this two part system, the only time you need to deal with the lock assembly is in cases of key and lock problems such as broken keys or binding tumblers within the lock.

LIGHTING

Headlights

Headlights, like any other lighting device, can fail due to broken filaments. The front of any car is the worst possible location for a lighting device, since it is subject to impact, extreme temperature change and extensive vibration — all of which shorten the life of the light. The front of the car is also where good lighting is needed the most, so it is not uncommon to have to replace a headlight during ownership of a vehicle.

There are two general styles of headlamp, sealed beam and replacable bulb types. The sealed beam is by far the most common and includes all the circular and rectangular lamps found on most cars built through the early 1980s. The sealed beam is so named because it includes the lamp (filament), the reflector and the lens in one sealed unit. Sealed beams are available in several standard sizes and shapes.

The replacable bulb is the newer technology. Using a small halogen bulb, only the lamp is replaced, while the lens and reflector are part of the body of the car. This is generally the style found on the "European" or wrap-around lighting systems. While the replacement bulbs are more expensive than sealed beams, they tend to produce more and better light. The fixed lenses and reflectors can be engineered to allow better frontal styling and better light distribution for a particular vehicle.

It is quite possible to replace a headlight of either type without affecting the alignment (aim) of the light. Sealed beams mount into a bracket (bucket) to which springs are attached. The adjusting screws control the position of the bucket which in turn aims the light. Replaceable bulbs simply fit into the back of the reflector; the reflector and lens are aimed by separate adjusting screws. Take a moment before disassembly to identify the large adjusting screws (generally two for each lamp) and don't change their settings.

With the exception of the oldest cars, sealed beams are always removed from the front of the car. Start with the outer trim pieces and work your way in to the lamp and its retainer. Bulb type units are usually replaced from the back of the reflector under the hood.

REMOVAL & INSTALLATION

Sealed Beam

✱✱CAUTION

Trim and headlight components can have sharp edges. Work carefully and wear gloves when changing headlights. Never push on the lens of a headlight or attempt to pry it into position.

140 SERIES

1. Open the hood and remove the headlight plug by pulling it straight out.
2. Loosen the three screws so that the plastic headlight retainers can be removed.
3. Remove the sealed beam from the engine compartment.
4. Reverse the above procedure to install, and recheck headlight alignment.

164 MODELS

1. Remove the headlight outer trim rim by pulling it upward and away from the car.
2. Loosen the three small screws a few turns so that the inner trim ring may be rotated and removed. Don't remove the screws and don't turn the two larger adjusting screws.
3. Pull out the sealed beam slightly and remove the wiring connector at the rear.
4. Reverse the above procedure to install, and recheck headlight alignment.

1800 SERIES

1. Remove the headlight outer chrome rim by removing the retaining screw at the lower part of the rim.
2. Remove the three screws holding the inner rim.
3. Pull out the sealed beam slightly and remove the headlight connector.
4. Reverse the above procedure to install, and recheck the headlight alignment.

200 SERIES AND EARLY 700 SERIES

◗ See Figures 61, 62, 63, 64, 65, 66 and 67

1. Disconnect the negative battery cable.
2. Raise the hood and turn the two plastic screws which retain the headlight trim ½ turn and remove the headlight trim.
3. For cars with single round headlamps, turn the chromed headlight retainer slightly counterclockwise, remove the retainer and lift out the headlight. For cars with dual round headlamps, unsnap the four clips and remove the headlight retainer and the headlight. For cars with dual rectangular headlamps, remove the four small screws holding the retainer. Remove the retainer and the headlamp.
4. Unplug the electrical connector and dispose of the old headlamp.
5. Installation is the reverse of removal.

➡In 1986, the 760 series introduced a different type of trim retaining clip. Instead of turning two plastic screws, locate the clip in the top center of the trim panel, squeeze the two sides together and pull it upwards to release the trim.

Replaceable Bulb

1985-89 200 SERIES AND 1987-89 700 SERIES

◗ See Figure 68

➡On 780 models, it may be necessary to remove the washer fluid fill tube to gain access to the bulb holder.

1. Make sure the headlights are off and the ignition is **OFF**.
2. Working from under the hood, release the clip and remove the wire connector from the back of the lamp assembly.

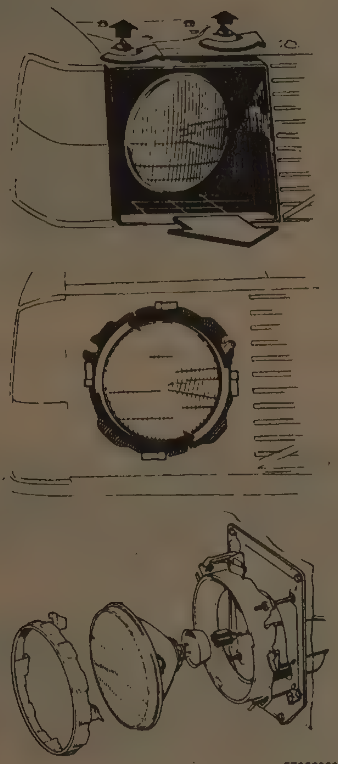

Fig. 62 Mounting position of the single round headlight — 200 series

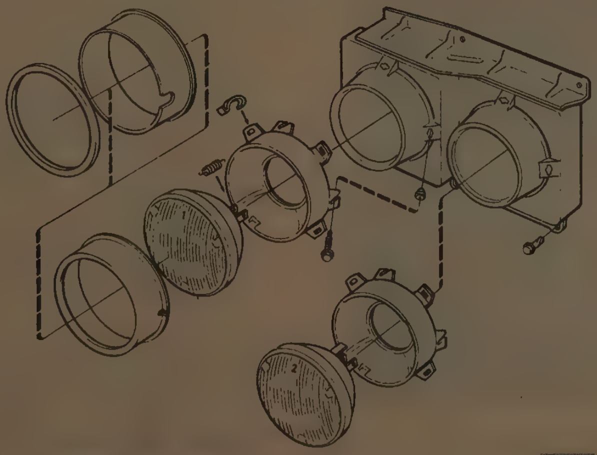

Fig. 61 Exploded view of dual round headlight mounting — 200 series

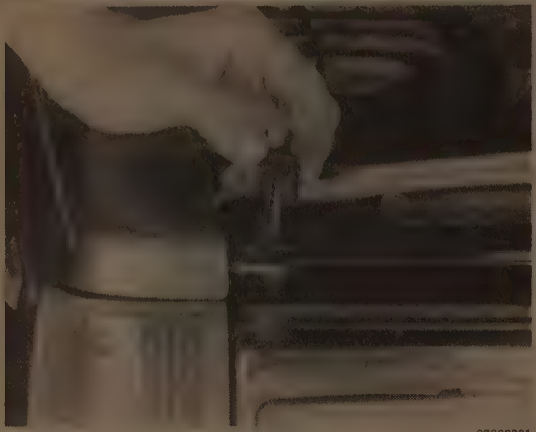

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Fig. 63 Remove the fasteners retaining the headlight trim

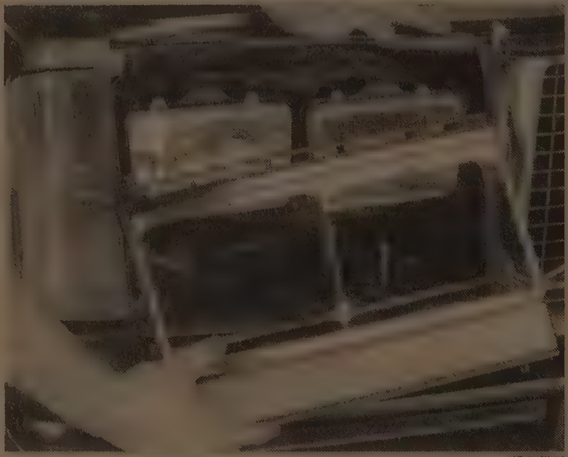

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Fig. 64 Once detached, set aside the trim piece

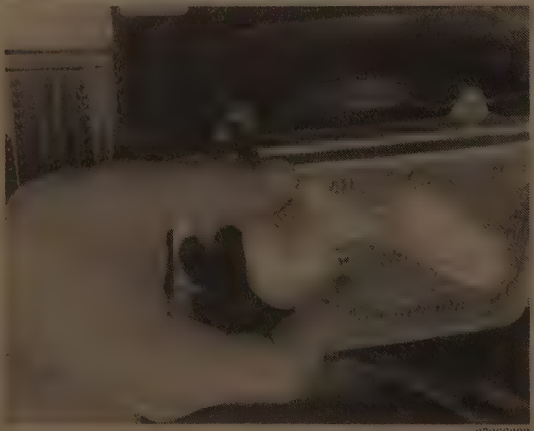

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Fig. 65 Unscrew the chrome headlight trim ring to release the sealed unit

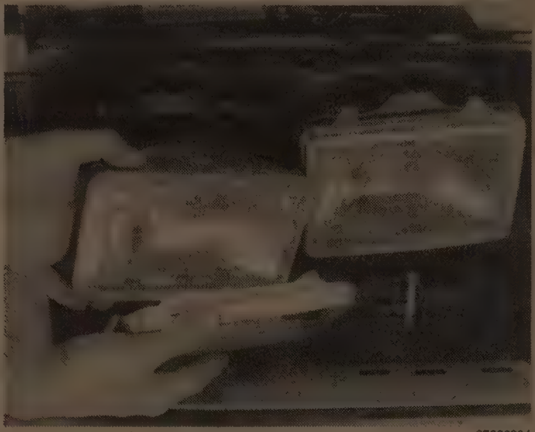

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Fig. 66 Remove the trim ring while supporting the headlight to prevent it from falling

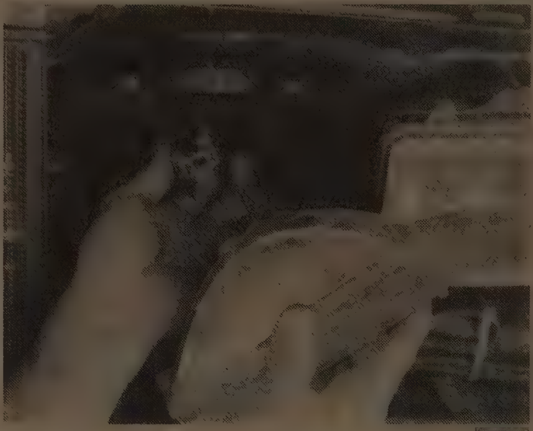


Fig. 67 Unplug the three-prong connector from the headlight and remove

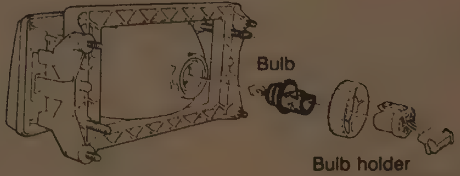


Fig. 68 Replaceable headlight bulb mounting — 780 shown, others similar

3. Unscrew and remove the large locking ring on the back of the headlamp.
4. Remove the bulb and its holder; replace them as a unit

**WARNING

When installing new bulbs, never touch the glass bulb with your fingers. The grease will develop a hot spot on the bulb and radically shorten its life.

5. When reinstalling, make sure that the bulb sits properly in the reflector assembly. Tighten the locking ring and reattach the wiring connector.

Signal and Marker Lights

REMOVAL & INSTALLATION

Front Turn Signal and Marker Lights

➧ See Figures 69, 70, 71, 72 and 73

The turn signals and side marker lights are generally reached by removing the lens. Front lenses through 1984-85 are retained by two screws; remove the screws and the lens. Don't lose the rubber gasket under the lens as it serves to keep water out of the lamp. With the lens off, the bulb can be removed with a half-turn counterclockwise. Wear gloves or wrap the bulb in a rag when removing as old bulbs frequently shatter when turned. Install the new bulb and turn the lights on to check bulb function. Install the gasket and the lens, but don't overtighten the mounting screws — you can crack the lens.

In the mid-1980s, the government required sealed lighting units to prevent moisture intrusion. If no mounting screws are visible on the front of the lens, the bulb is reached from under the hood. After identifying the proper lamp, simply grasp the base of the socket, turn it counterclockwise and remove the bulb and socket from the housing. Using gloves or a rag, remove the bulb from the socket either with a turn to the left or, for smaller lamps, by pulling the the bulb straight out. After installing the new bulb, turn the lights on to check the bulb function before replacing the socket in the housing. After the socket is in the housing, lock it in place with a half-turn clockwise.

Rear Turn Signal, Brake, Parking and Marker Lights

➧ See Figures 74, 75, 76, 77 and 78

With the exception of station wagons through 1980, all rear light bulbs are reached from the inside of the trunk. Until 1981 the station wagons required the removal of the lens from the outside. With the lens off, the bulb is removed with a ¼ twist counterclockwise.

Since Volvo uses a multi-lamp arrangement at the rear, it is prudent to identify which light is inoperative before being confronted with an array of six or eight lamp holders inside the trunk. Remove the interior cover panel either by unscrewing

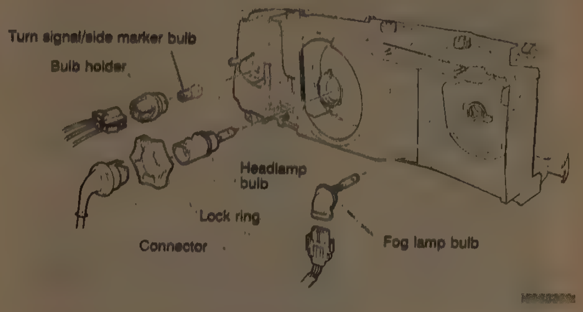


Fig. 69 Exploded view of the front lighting assembly

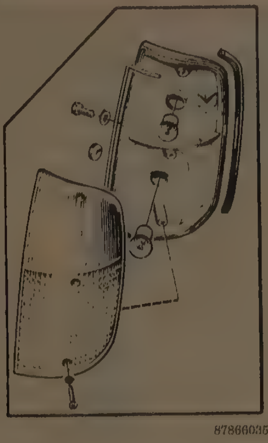


Fig. 70 Exploded view of front sidemarker and turn signal assemblies — prior to 1986

Fig. 71 Remove the Phillips screws retaining the turn signal lens

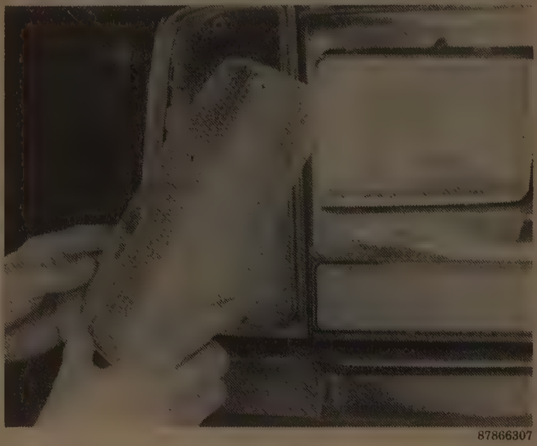


Fig. 72 Once detached, set the lens aside in a safe place along with the hardware

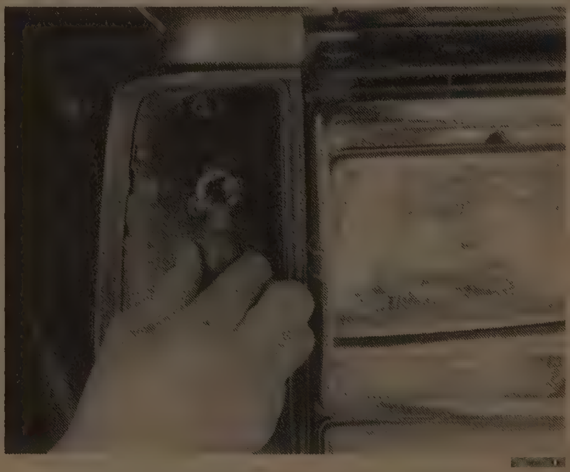


Fig. 73 Turn the bulb counterclockwise and remove

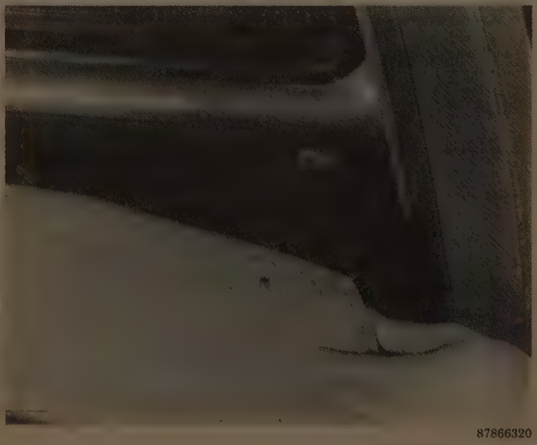


Fig. 74 Remove the interior cover panel to access the multi-lamp taillight unit

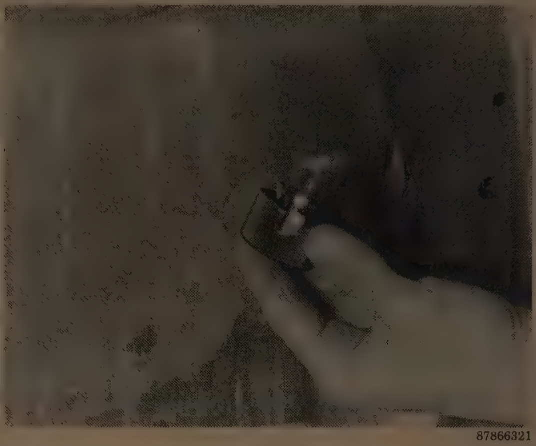


Fig. 75 Twist the bulb holder about 1/4 turn counterclockwise to release it from its mounting

the knob (if so equipped) or by popping the panel off with a small screwdriver.

➡To reach the left side rear lamps on station wagons built after 1980, it is necessary to remove the spare tire and its cover.

After the cover is removed:

1. Locate the bulb holder for the appropriate bulb and turn it about ¼ turn counterclockwise.
2. Remove the bulb holder and replace the bulb. Make sure that the new bulb is an exact match for the old one and is properly seated in the holder.
3. Reinstall the bulb and holder. Note that one of the guide tabs on the bulb holder is wider than the other two; it can only be installed in one position.
4. Check the function of the bulb by turning on the appropriate lights.
5. Replace the cover(s) and, on wagons, replace the spare tire and cover.

Fig. 76 Replace the bulb with the exact same type of bulb, then install

TRAILER WIRING

Wiring the car for towing is fairly easy. There are a number of good wiring kits available and one of these should be used, rather than trying to design your own. All trailers will need brake lights and turn signals as well as tail lights and side marker lights. Most states require extra marker lights for overly wide trailers. Also, most states require back-up lights for trailers, and most trailer manufacturers have been building trailers with back-up lights for several years.

Additionally, some Class I, most Class II and just about all Class III trailers will have electric brakes.

Add to this number an accessories wire, to operate trailer internal equipment or to charge the trailer's battery, and you can have as many as seven wires in the harness.

Determine the equipment on your trailer and buy the wiring kit necessary. The kit will contain all the wires needed, plus a plug adapter set which included the female plug, mounted on the bumper or hitch, and the male plug, wired into, or plugged into the trailer harness.

When installing the kit, follow the manufacturer's instructions. The color coding of the wires is standard throughout the industry.

One point to note, some domestic vehicles, and most imported vehicles, have separate turn signals. On most domestic vehicles, the brake lights and rear turn signals operate with the same bulb. For those vehicles without separate turn signals, you can purchase an isolation unit so that the brake lights won't blink whenever the turn signals are operated, or, you can go to your local electronics supply house and buy four diodes to wire in series with the brake and turn signal bulbs. Diodes will isolate the brake and turn signals. The choice is yours. The isolation units are simple and quick to install, but far more expensive than the diodes. The diodes, however, require more work to install properly, since they require the cutting of each bulb's wire and soldering in place of the diode.

One final point, the best kits are those with a spring loaded cover on the vehicle mounted socket. This cover prevents dirt and moisture from corroding the terminals. Never let the vehicle socket hang loosely. Always mount it securely to the bumper or hitch.

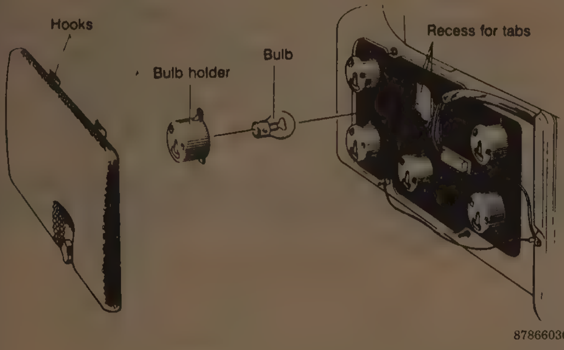


Fig. 77 Exploded view of the tail lamp assembly — 240 shown, most others are similar

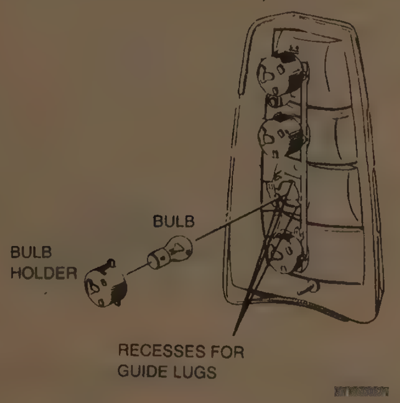


Fig. 78 Tail lamp assembly mounting — 1980 and later station wagons

CIRCUIT PROTECTION

Fuses

LOCATION & REPLACEMENT

➧ See Figures 79, 80, 81, 82 and 83

All electrical equipment is protected from overloading by fuses. Each fuse has an amperage rating that will allow it to transmit a predetermined amount of current before its filament melts, thereby stopping the excessive current flow. By providing this engineered "weak spot" in the circuit, the first failure will occur at a known location (the fuse), eliminating hours of tracing wiring harnesses to locate a problem.

If a fuse blows repeatedly, the trouble is probably in the electrical component that the fuse protects. Never replace a fuse with another of a higher ampere rating. Sometimes a fuse will blow when all of the electrical equipment protected by the fuse is operating, especially under severe weather conditions. For this reason, it is wise to carry a few spare fuses of each type in the car.

When tracking down an inoperative electrical circuit, follow a logical pattern. Wiring itself is rarely the problem on modern cars. Your time is better spent checking the fuse, the component(s) in the circuit, the circuit grounds and the wiring connectors. Remember that in some cases a fuse can look good

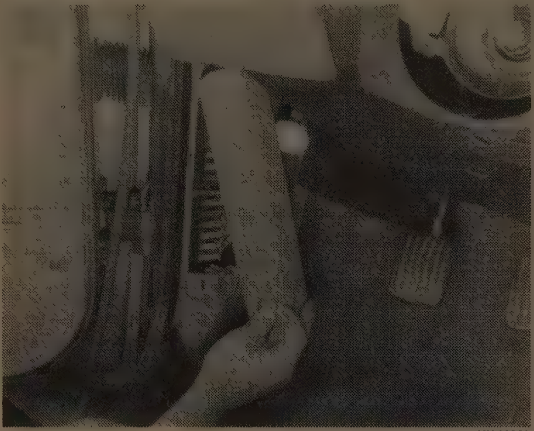


Fig. 79 Turn the knob on the bottom of the cover, then remove to access the fuse panel

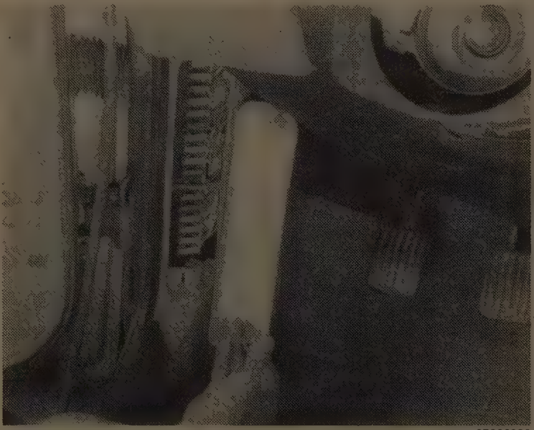


Fig. 80 The back of the fuse panel has a legend that locates each fuse and its describes its application

Fig. 81 Always install new fuses with the correct amperage

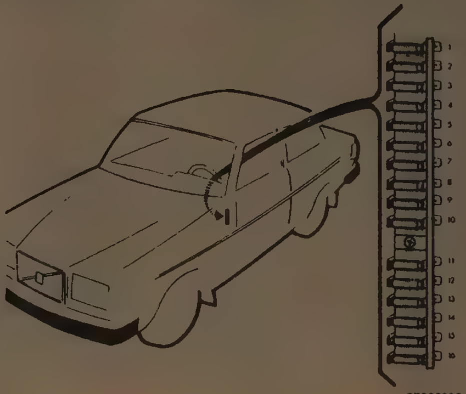


Fig. 82 Fusebox locations — 100 and 200 series

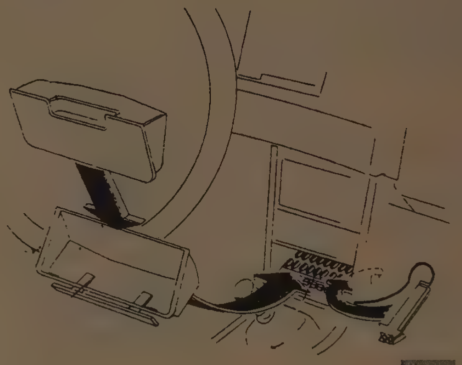


Fig. 83 Fusebox location — all 700 series models, except 1988-89 760

but not be capable of passing an electrical load. Either remove the fuse and check it with an ohmeter or simply replace it with a new one. Always have the ignition switched off when removing and replacing fuses. On all models, the circuit that each fuse protects is given either on the fuse box cover or in the owners manual. Volvo fuseboxes are located as follows:

- 1970-71 100 Series: Behind a snap-out panel in the dashboard above the transmission tunnel.
- 1972 100 Series: Over the transmission tunnel, behind the control panel for the clock, rear defroster and emergency flashers. Remove the two retaining screws at the upper corners of the panel and tilt the panel down.
- 1800 Series: Under the dashboard, to the driver's left.
- 1973 and later 100 and 200 Series: Behind a swing-out cover on the lower part of the left front pillar.
- 1984 through 1987 740 and 760 Series and all 780: Behind the ashtray in the center console. Remove the ashtray by pulling it out and pressing down on the tongue. Lift the cover marked "Electrical Fuses". The fuses can be pulled straight up

from the fusebox using either your fingers or the fuse puller provided.

- 1988-89 760 Series: On the left end of the dashboard, behind a swing-out panel. Spare fuses are located in a small tray which pulls out from the bottom of the fusebox.

➡On certain models with electronic fuel injection, an additional fuse for the fuel pump is housed in the engine compartment on the left wheel well. Diesel glow plug circuits have a separate fuse located on the bottom of the glow plug relay under the hood.

Turn Signal Flasher/Relay

LOCATION & REPLACEMENT

➧ See Figures 84 and 85

The flasher unit on 100 series and P1800 series is located behind the instrument cluster. It simply unplugs from its mount and is replaced easily.

On all subsequent models--200 and 700 Series--the flasher or relay is located behind the center console. The 200 Series cars use a single unit which is located to the left and below the heater controls panel. Removal of various console sidepanels may be necessary for access.

The 700 Series use a central relay console located behind the ashtray. To gain access to the relay panel:

1. Remove the ashtray and its holder.
2. Remove the cigarette lighter and its cover.
3. Unscrew the case retaining screws (for the ashtray casing) and remove the casing.
4. Depress the catch and slide the relay board towards you.

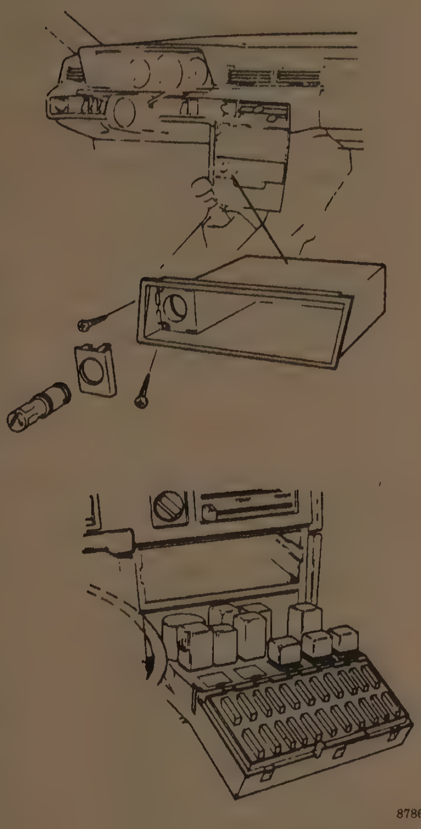


Fig. 85 The relay panel is accessed as shown — 700 series

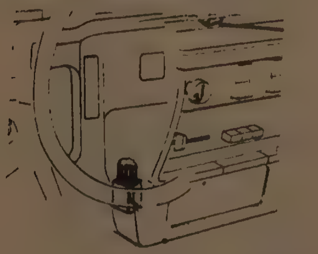
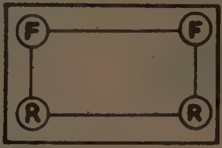
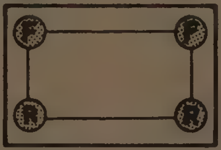
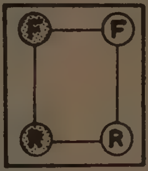
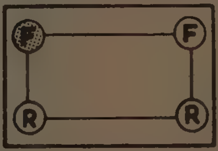
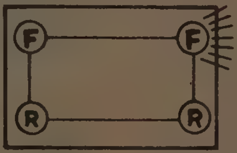
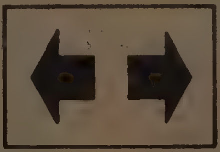
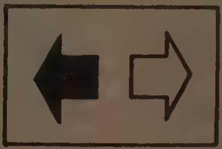


Fig. 84 Location of the turn signal flasher — 100 and 200 series

Troubleshooting Basic Turn Signal and Flasher Problems

Most problems in the turn signals or flasher system, can be reduced to defective flashers or bulbs, which are easily replaced. Occasionally, problems in the turn signals are traced to the switch in the steering column, which will require professional service.

F = Front R = Rear ● = Lights off o = Lights on

Problem		Solution
Turn signals light, but do not flash		• Replace the flasher
No turn signals light on either side		• Check the fuse. Replace if defective. • Check the flasher by substitution • Check for open circuit, short circuit or poor ground
Both turn signals on one side don't work		• Check for bad bulbs • Check for bad ground in both housings
One turn signal light on one side doesn't work		• Check and/or replace bulb • Check for corrosion in socket. Clean contacts. • Check for poor ground at socket
Turn signal flashes too fast or too slow		• Check any bulb on the side flashing too fast. A heavy-duty bulb is probably installed in place of a regular bulb. • Check the bulb flashing too slow. A standard bulb was probably installed in place of a heavy-duty bulb. • Check for loose connections or corrosion at the bulb socket
Indicator lights don't work in either direction		• Check if the turn signals are working • Check the dash indicator lights • Check the flasher by substitution
One indicator light doesn't light		• On systems with 1 dash indicator: See if the lights work on the same side. Often the filaments have been reversed in systems combining stoplights with taillights and turn signals. Check the flasher by substitution • On systems with 2 indicators: Check the bulbs on the same side Check the indicator light bulb Check the flasher by substitution

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Troubleshooting Basic Dash Gauge Problems

Problem	Cause	Solution
Coolant Temperature Gauge		
Gauge reads erratically or not at all	• Loose or dirty connections	• Clean/tighten connections
	• Defective sending unit	• Bi-metal gauge: remove the wire from the sending unit. Ground the wire for an instant. If the gauge registers, replace the sending unit.
	• Defective gauge	• Magnetic gauge: disconnect the wire at the sending unit. With ignition ON gauge should register COLD. Ground the wire; gauge should register HOT.
Ammeter Gauge—Turn Headlights ON (do not start engine). Note reaction		
Ammeter shows charge	• Connections reversed on gauge	• Reinstall connections
Ammeter shows discharge	• Ammeter is OK	• Nothing
Ammeter does not move	• Loose connections or faulty wiring	• Check/correct wiring
	• Defective gauge	• Replace gauge
Oil Pressure Gauge		
Gauge does not register or is inaccurate	• On mechanical gauge, Bourdon tube may be bent or kinked	• Check tube for kinks or bends preventing oil from reaching the gauge
	• Low oil pressure	• Remove sending unit. Idle the engine briefly. If no oil flows from sending unit hole, problem is in engine.
	• Defective gauge	• Remove the wire from the sending unit and ground it for an instant with the ignition ON. A good gauge will go to the top of the scale.
	• Defective wiring	• Check the wiring to the gauge. If it's OK and the gauge doesn't register when grounded, replace the gauge.
	• Defective sending unit	• If the wiring is OK and the gauge functions when grounded, replace the sending unit
All Gauges		
All gauges do not operate	• Blown fuse	• Replace fuse
	• Defective instrument regulator	• Replace instrument voltage regulator
All gauges read low or erratically	• Defective or dirty instrument voltage regulator	• Clean contacts or replace
All gauges pegged	• Loss of ground between instrument voltage regulator and car	• Check ground
	• Defective instrument regulator	• Replace regulator
Warning Lights		
Light(s) do not come on when ignition is ON, but engine is not started	• Defective bulb	• Replace bulb
	• Defective wire	• Check wire from light to sending unit
	• Defective sending unit	• Disconnect the wire from the sending unit and ground it. Replace the sending unit if the light comes on with the ignition ON.
Light comes on with engine running	• Problem in individual system	• Check system
	• Defective sending unit	• Check sending unit (see above)

Troubleshooting the Heater

Problem	Cause	Solution
Blower motor will not turn at any speed	• Blown fuse • Loose connection • Defective ground • Faulty switch • Faulty motor • Faulty resistor	• Replace fuse • Inspect and tighten • Clean and tighten • Replace switch • Replace motor • Replace resistor
Blower motor turns at one speed only	• Faulty switch • Faulty resistor	• Replace switch • Replace resistor
Blower motor turns but does not circulate air	• Intake blocked • Fan not secured to the motor shaft	• Clean intake • Tighten security
Heater will not heat	• Coolant does not reach proper temperature • Heater core blocked internally • Heater core air-bound • Blend-air door not in proper position	• Check and replace thermostat if necessary • Flush or replace core if necessary • Purge air from core • Adjust cable
Heater will not defrost	• Control cable adjustment incorrect • Defroster hose damaged	• Adjust control cable • Replace defroster hose

Troubleshooting Basic Windshield Wiper Problems

Problem	Cause	Solution
Electric Wipers		
Wipers do not operate— Wiper motor heats up or hums	• Internal motor defect • Bent or damaged linkage • Arms improperly installed on linking pivots	• Replace motor • Repair or replace linkage • Position linkage in park and reinstall wiper arms
Wipers do not operate— No current to motor	• Fuse or circuit breaker blown • Loose, open or broken wiring • Defective switch • Defective or corroded terminals • No ground circuit for motor or switch	• Replace fuse or circuit breaker • Repair wiring and connections • Replace switch • Replace or clean terminals • Repair ground circuits
Wipers do not operate— Motor runs	• Linkage disconnected or broken	• Connect wiper linkage or replace broken linkage
Vacuum Wipers		
Wipers do not operate	• Control switch or cable inoperative • Loss of engine vacuum to wiper motor (broken hoses, low engine vacuum, defective vacuum/fuel pump) • Linkage broken or disconnected • Defective wiper motor	• Repair or replace switch or cable • Check vacuum lines, engine vacuum and fuel pump • Repair linkage • Replace wiper motor
Wipers stop on engine acceleration	• Leaking vacuum hoses • Dry windshield • Oversize wiper blades • Defective vacuum/fuel pump	• Repair or replace hoses • Wet windshield with washers • Replace with proper size wiper blades • Replace pump

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Troubleshooting Basic Lighting Problems

Problem	Cause	Solution
Lights		
One or more lights don't work, but others do	• Defective bulb(s) • Blown fuse(s) • Dirty fuse clips or light sockets • Poor ground circuit	• Replace bulb(s) • Replace fuse(s) • Clean connections • Run ground wire from light socket housing to car frame
Lights burn out quickly	• Incorrect voltage regulator setting or defective regulator • Poor battery/alternator connections	• Replace voltage regulator • Check battery/alternator connections
Lights go dim	• Low/discharged battery • Alternator not charging • Corroded sockets or connections • Low voltage output	• Check battery • Check drive belt tension; repair or replace alternator • Clean bulb and socket contacts and connections • Replace voltage regulator
Lights flicker	• Loose connection • Poor ground • Circuit breaker operating (short circuit)	• Tighten all connections • Run ground wire from light housing to car frame • Check connections and look for bare wires
Lights "flare"—Some flare is normal on acceleration—if excessive, see "Lights Burn Out Quickly"	• High voltage setting	• Replace voltage regulator
Lights glare—approaching drivers are blinded	• Lights adjusted too high • Rear springs or shocks sagging • Rear tires soft	• Have headlights aimed • Check rear springs/shocks • Check/correct rear tire pressure
Turn Signals		
Turn signals don't work in either direction	• Blown fuse • Defective flasher • Loose connection	• Replace fuse • Replace flasher • Check/tighten all connections
Right (or left) turn signal only won't work	• Bulb burned out • Right (or left) indicator bulb burned out • Short circuit	• Replace bulb • Check/replace indicator bulb • Check/repair wiring
Flasher rate too slow or too fast	• Incorrect wattage bulb • Incorrect flasher	• Flasher bulb • Replace flasher (use a variable load flasher if you pull a trailer)
Indicator lights do not flash (burn steadily)	• Burned out bulb • Defective flasher	• Replace bulb • Replace flasher
Indicator lights do not light at all	• Burned out indicator bulb • Defective flasher	• Replace indicator bulb • Replace flasher

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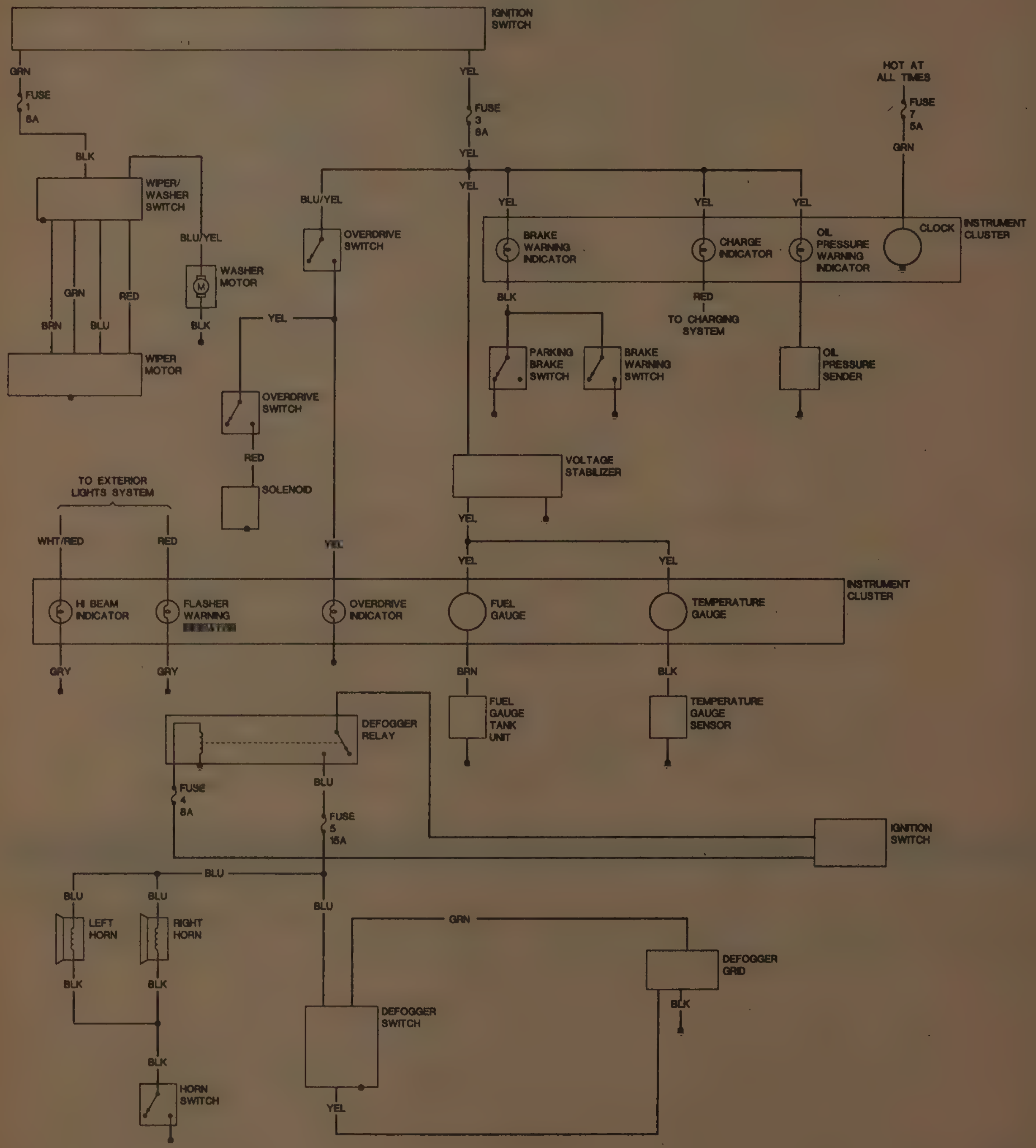
WIRING DIAGRAMS

➡Unless specifically stated otherwise, each chart for a given model year covers ALL vehicles covered by this manual. Charts that cover a range of years or are for only a limited series of vehicles within a model year (for example, "EFI-equipped," or "diesel," etc.) will be noted accordingly. Make sure you consult the correct chart for your particular vehicle.


IGNITION SWITCH
GRN
FUSE 1 8A
BLK
WIPER/ WASHER SWITCH
BLU/YEL
WASHER MOTOR
BLK
GRN
RED
BRN
BLU
WIPER MOTOR
YEL
FUSE 3 8A
YEL
YEL
BLU/YEL
OVERDRIVE SWITCH
YEL
OVERDRIVE SWITCH
RED
SOLENOID
HOT AT ALL TIMES
FUSE 7 5A
GRN
YEL
YEL
YEL
BRAKE WARNING INDICATOR
CHARGE INDICATOR
OIL PRESSURE WARNING INDICATOR
CLOCK
INSTRUMENT CLUSTER
BLK
RED
TO CHARGING SYSTEM
PARKING BRAKE SWITCH
BRAKE WARNING SWITCH
OIL PRESSURE SENDER
VOLTAGE STABILIZER
YEL
YEL
YEL
TO EXTERIOR LIGHTS SYSTEM
WHT/RED
RED
YEL
HI BEAM INDICATOR
FLASHER WARNING [redacted]
OVERDRIVE INDICATOR
FUEL GAUGE
TEMPERATURE GAUGE
INSTRUMENT CLUSTER
GRY
GRY
BRN
BLK
FUEL GAUGE TANK UNIT
TEMPERATURE GAUGE SENSOR
DEFOGGER RELAY
FUSE 4 8A
BLU
FUSE 5 15A
IGNITION SWITCH
BLU
BLU
BLU
BLU
LEFT HORN
RIGHT HORN
BLK
BLK
BLK
HORN SWITCH
GRN
DEFOGGER GRID
BLK
DEFOGGER SWITCH
YEL

87866401

Fig. 86 Chassis wiring — 1970-71 142 GL and 144 GL

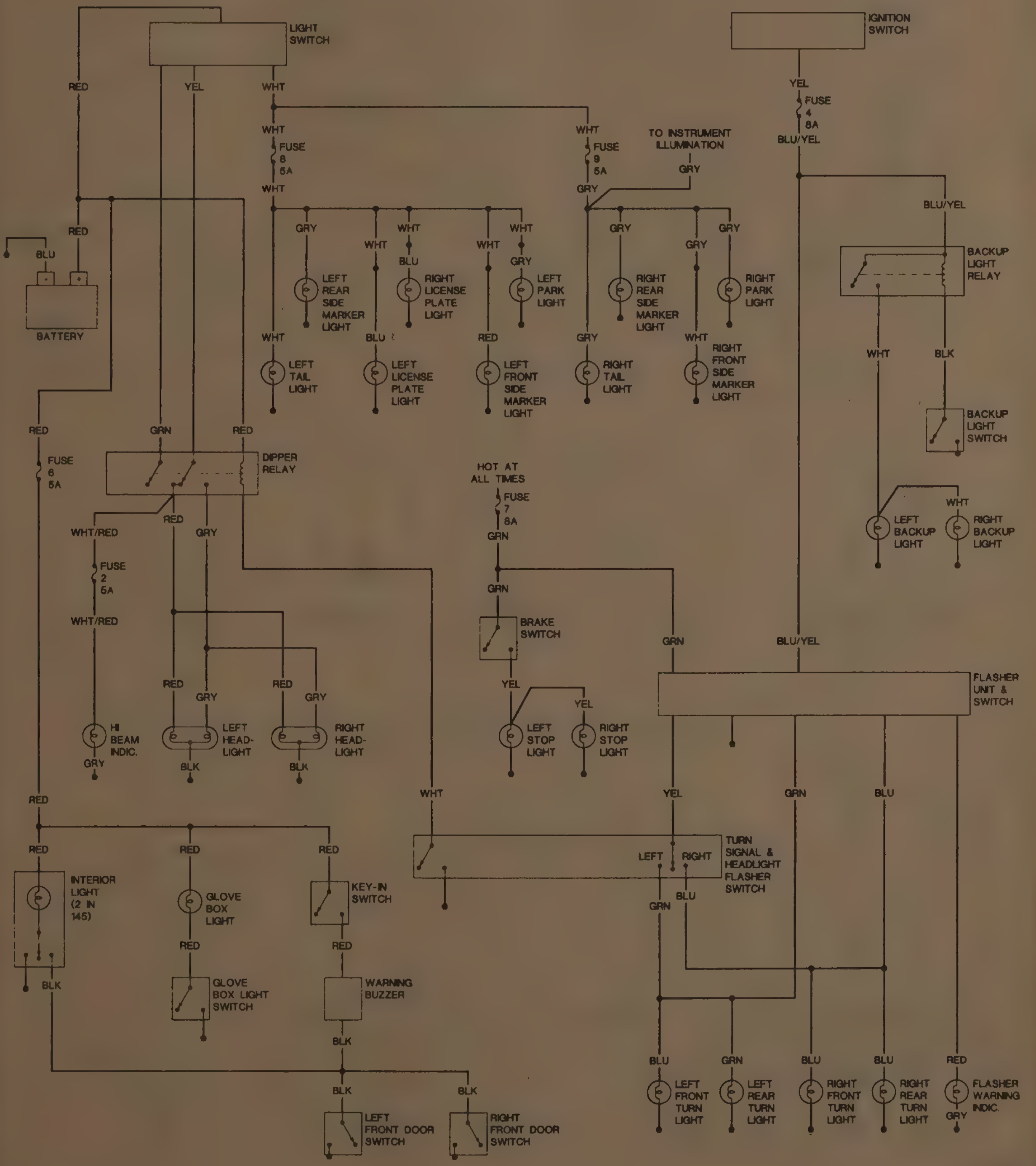

LIGHT SWITCH
RED
YEL
WHT
IGNITION SWITCH
YEL
FUSE 4 8A
BLU/YEL
WHT
FUSE 8 5A
WHT
WHT
FUSE 9 5A
GRY
TO INSTRUMENT ILLUMINATION
GRY
BLU/YEL
RED
BLU
BATTERY
GRY
WHT
WHT
BLU
WHT
WHT
GRY
LEFT REAR SIDE MARKER LIGHT
RIGHT LICENSE PLATE LIGHT
LEFT PARK LIGHT
GRY
GRY
GRY
RIGHT REAR SIDE MARKER LIGHT
RIGHT PARK LIGHT
BACKUP LIGHT RELAY
WHT
BLU
RED
GRY
WHT
LEFT TAIL LIGHT
LEFT LICENSE PLATE LIGHT
LEFT FRONT SIDE MARKER LIGHT
RIGHT TAIL LIGHT
RIGHT FRONT SIDE MARKER LIGHT
WHT
BLK
BACKUP LIGHT SWITCH
RED
GRN
RED
FUSE 6 5A
DIPPER RELAY
HOT AT ALL TIMES
FUSE 7 8A
GRN
WHT
LEFT BACKUP LIGHT
RIGHT BACKUP LIGHT
WHT/RED
RED
GRY
FUSE 2 5A
WHT/RED
GRN
BRAKE SWITCH
GRN
BLU/YEL
FLASHER UNIT & SWITCH
RED
GRY
RED
GRY
YEL
YEL
HI BEAM INDIC.
GRY
LEFT HEAD-LIGHT
BLK
RIGHT HEAD-LIGHT
BLK
LEFT STOP LIGHT
RIGHT STOP LIGHT
RED
WHT
YEL
GRN
BLU
RED
RED
RED
TURN SIGNAL & HEADLIGHT FLASHER SWITCH
LEFT
RIGHT
INTERIOR LIGHT (2 IN 145)
GLOVE BOX LIGHT
KEY-IN SWITCH
BLU
GRN
RED
RED
BLK
GLOVE BOX LIGHT SWITCH
WARNING BUZZER
BLK
BLU
GRN
BLU
BLU
RED
BLK
BLK
LEFT FRONT TURN LIGHT
LEFT REAR TURN LIGHT
RIGHT FRONT TURN LIGHT
RIGHT REAR TURN LIGHT
FLASHER WARNING INDIC.
GRY
LEFT FRONT DOOR SWITCH
RIGHT FRONT DOOR SWITCH

Fig. 87 Chassis wiring — 1970-71 142, 142 GL and 144 GL (continued)

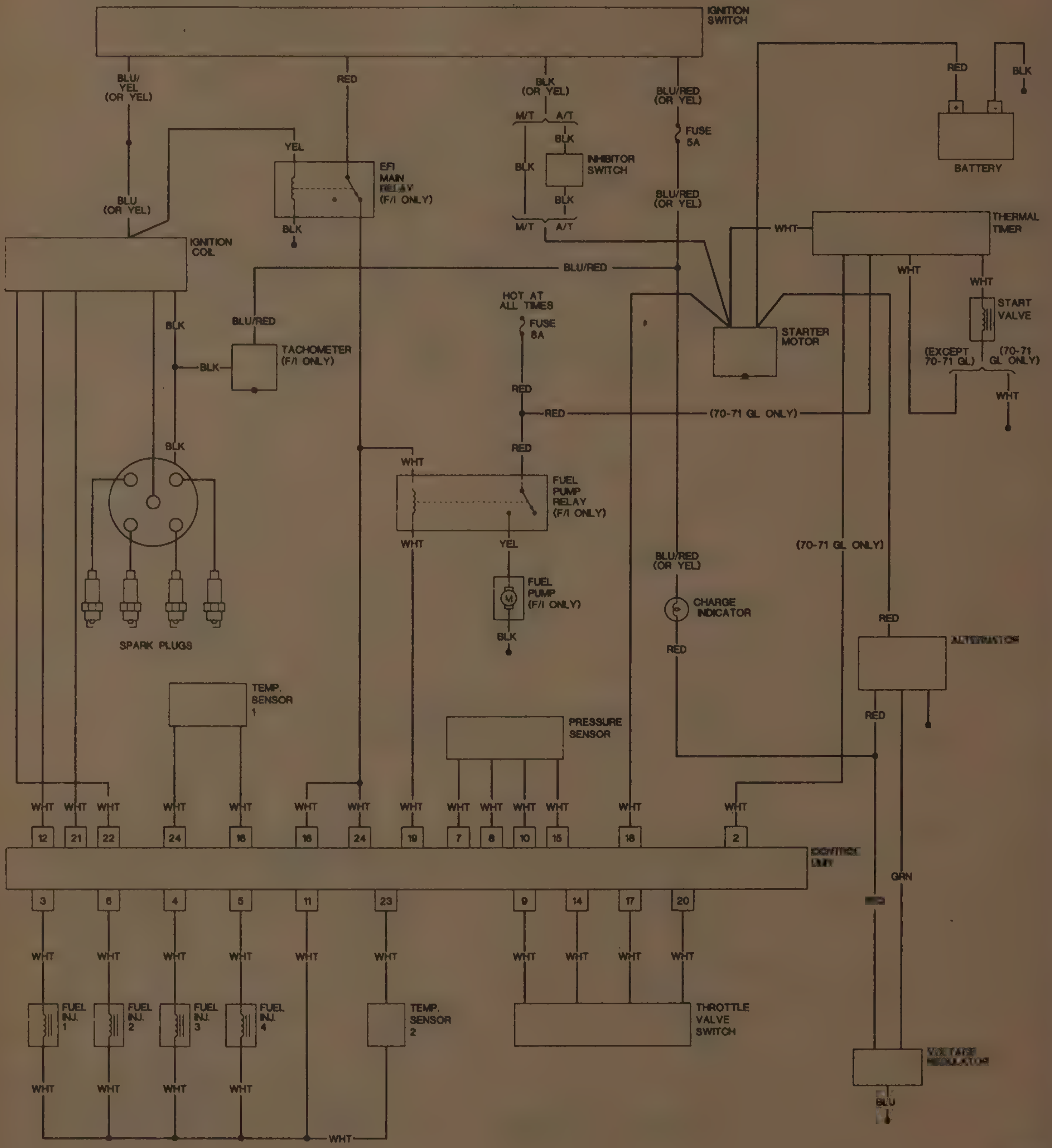

IGNITION SWITCH
BLU/YEL (OR YEL)
RED
BLK (OR YEL)
BLU/RED (OR YEL)
FUSE 5A
RED
BLK
BATTERY
YEL
EFI MAIN RELAY (F/I ONLY)
M/T
A/T
BLK
INHIBITOR SWITCH
BLU/RED (OR YEL)
BLU (OR YEL)
IGNITION COIL
WHT
THERMAL TIMER
BLU/RED
HOT AT ALL TIMES
FUSE 8A
START VALVE
STARTER MOTOR
TACHOMETER (F/I ONLY)
(EXCEPT 70-71 GL)
(70-71 GL ONLY)
RED
(70-71 GL ONLY)
FUEL PUMP RELAY (F/I ONLY)
FUEL PUMP (F/I ONLY)
CHARGE INDICATOR
SPARK PLUGS
ALTERNATOR
TEMP. SENSOR 1
PRESSURE SENSOR
GRN
CONTROL UNIT
12
21
22
24
16
16
24
19
7
8
10
15
18
2
3
6
4
5
11
23
9
14
17
20
FUEL INJ. 1
FUEL INJ. 2
FUEL INJ. 3
FUEL INJ. 4
TEMP. SENSOR 2
THROTTLE VALVE SWITCH
VOLTAGE REGULATOR
BLU

Fig. 88 Engine wiring — 1970-74 140 series

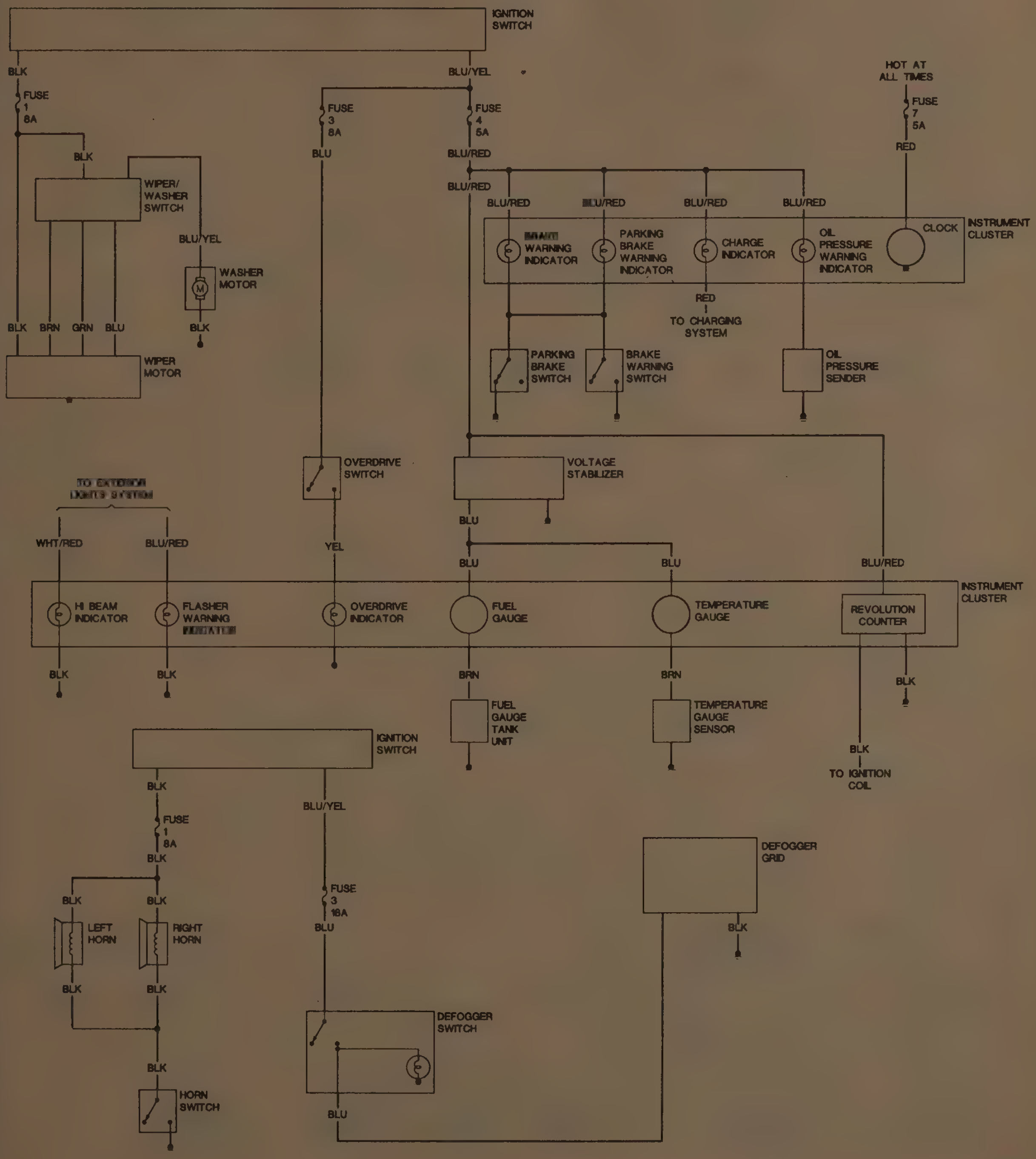

IGNITION SWITCH
BLK
FUSE 1 8A
BLK
WIPER/ WASHER SWITCH
BLU/YEL
WASHER MOTOR
BLK
BLK
BRN
GRN
BLU
WIPER MOTOR
BLU/YEL
FUSE 3 8A
BLU
FUSE 4 5A
BLU/RED
BLU/RED
BLU/RED
BLU/RED
BLU/RED
BLU/RED
HOT AT ALL TIMES
FUSE 7 5A
RED
BRAKE WARNING INDICATOR
PARKING BRAKE WARNING INDICATOR
CHARGE INDICATOR
OIL PRESSURE WARNING INDICATOR
CLOCK
INSTRUMENT CLUSTER
RED
TO CHARGING SYSTEM
PARKING BRAKE SWITCH
BRAKE WARNING SWITCH
OIL PRESSURE SENDER
OVERDRIVE SWITCH
VOLTAGE STABILIZER
TO EXTERIOR LIGHTS SYSTEM
WHT/RED
BLU/RED
YEL
BLU
BLU
BLU
BLU/RED
INSTRUMENT CLUSTER
HI BEAM INDICATOR
FLASHER WARNING INDICATOR
OVERDRIVE INDICATOR
FUEL GAUGE
TEMPERATURE GAUGE
REVOLUTION COUNTER
BLK
BLK
BRN
BRN
BLK
FUEL GAUGE TANK UNIT
TEMPERATURE GAUGE SENSOR
BLK
TO IGNITION COIL
IGNITION SWITCH
BLK
FUSE 1 8A
BLK
BLU/YEL
BLK
BLK
LEFT HORN
RIGHT HORN
BLK
BLK
BLK
HORN SWITCH
FUSE 3 16A
BLU
DEFOGGER GRID
BLK
DEFOGGER SWITCH
BLU
87866404

Fig. 89 Chassis wiring — 1970-75 142, 144 and 145

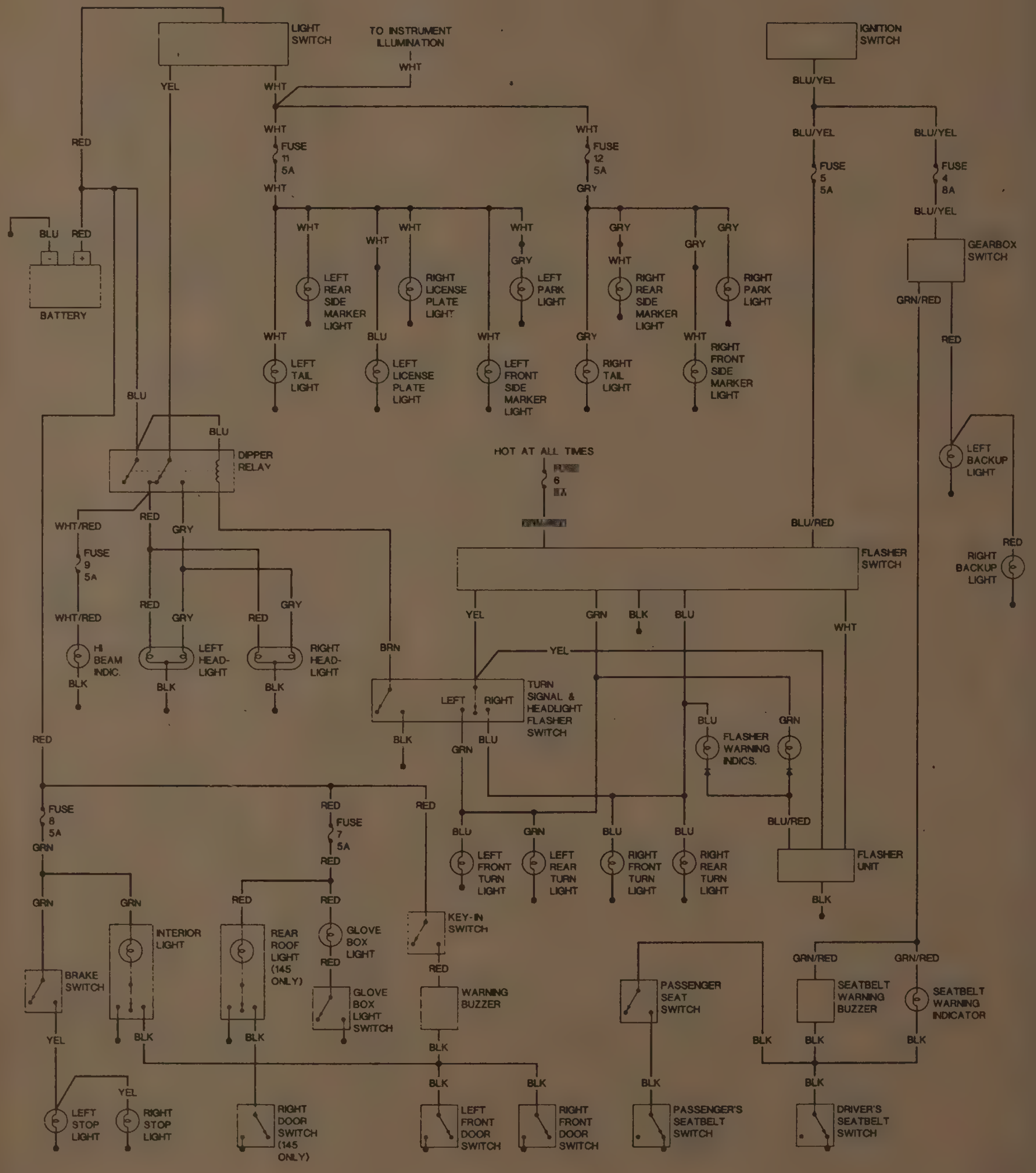

LIGHT SWITCH
TO INSTRUMENT ILLUMINATION
WHT
YEL
WHT
RED
WHT
FUSE 11 5A
WHT
WHT
FUSE 12 5A
GRY
WHT
WHT
WHT
WHT
GRY
LEFT REAR SIDE MARKER LIGHT
RIGHT LICENSE PLATE LIGHT
LEFT PARK LIGHT
GRY
GRY
GRY
WHT
RIGHT REAR SIDE MARKER LIGHT
RIGHT PARK LIGHT
WHT
BLU
WHT
GRY
WHT
LEFT TAIL LIGHT
LEFT LICENSE PLATE LIGHT
LEFT FRONT SIDE MARKER LIGHT
RIGHT TAIL LIGHT
RIGHT FRONT SIDE MARKER LIGHT
IGNITION SWITCH
BLU/YEL
BLU/YEL
BLU/YEL
FUSE 5 5A
FUSE 4 8A
BLU/YEL
GEARBOX SWITCH
GRN/RED
RED
LEFT BACKUP LIGHT
RED
RIGHT BACKUP LIGHT
BLU
RED
BATTERY
BLU
BLU
DIPPER RELAY
HOT AT ALL TIMES
FUSE 6 8A
GRN/RED
BLU/RED
FLASHER SWITCH
WHT/RED
RED
GRY
FUSE 9 5A
RED
GRY
RED
GRY
WHT/RED
HI BEAM INDIC.
LEFT HEAD-LIGHT
RIGHT HEAD-LIGHT
BLK
BLK
BLK
BRN
YEL
GRN
BLK
BLU
WHT
YEL
LEFT
RIGHT
TURN SIGNAL & HEADLIGHT FLASHER SWITCH
BLK
GRN
BLU
BLU
GRN
FLASHER WARNING INDICS.
RED
BLU/RED
FUSE 8 5A
GRN
RED
FUSE 7 5A
RED
RED
BLU
GRN
BLU
BLU
LEFT FRONT TURN LIGHT
LEFT REAR TURN LIGHT
RIGHT FRONT TURN LIGHT
RIGHT REAR TURN LIGHT
FLASHER UNIT
BLK
GRN
GRN
RED
RED
INTERIOR LIGHT
REAR ROOF LIGHT (145 ONLY)
GLOVE BOX LIGHT
RED
KEY-IN SWITCH
RED
BRAKE SWITCH
GLOVE BOX LIGHT SWITCH
WARNING BUZZER
PASSENGER SEAT SWITCH
GRN/RED
GRN/RED
SEATBELT WARNING BUZZER
SEATBELT WARNING INDICATOR
YEL
BLK
BLK
BLK
BLK
BLK
BLK
YEL
BLK
BLK
BLK
BLK
LEFT STOP LIGHT
RIGHT STOP LIGHT
RIGHT DOOR SWITCH (145 ONLY)
LEFT FRONT DOOR SWITCH
RIGHT FRONT DOOR SWITCH
PASSENGER'S SEATBELT SWITCH
DRIVER'S SEATBELT SWITCH
87866405

Fig. 90 Chassis wiring — 1972-74 142, 144 and 145 (continued)

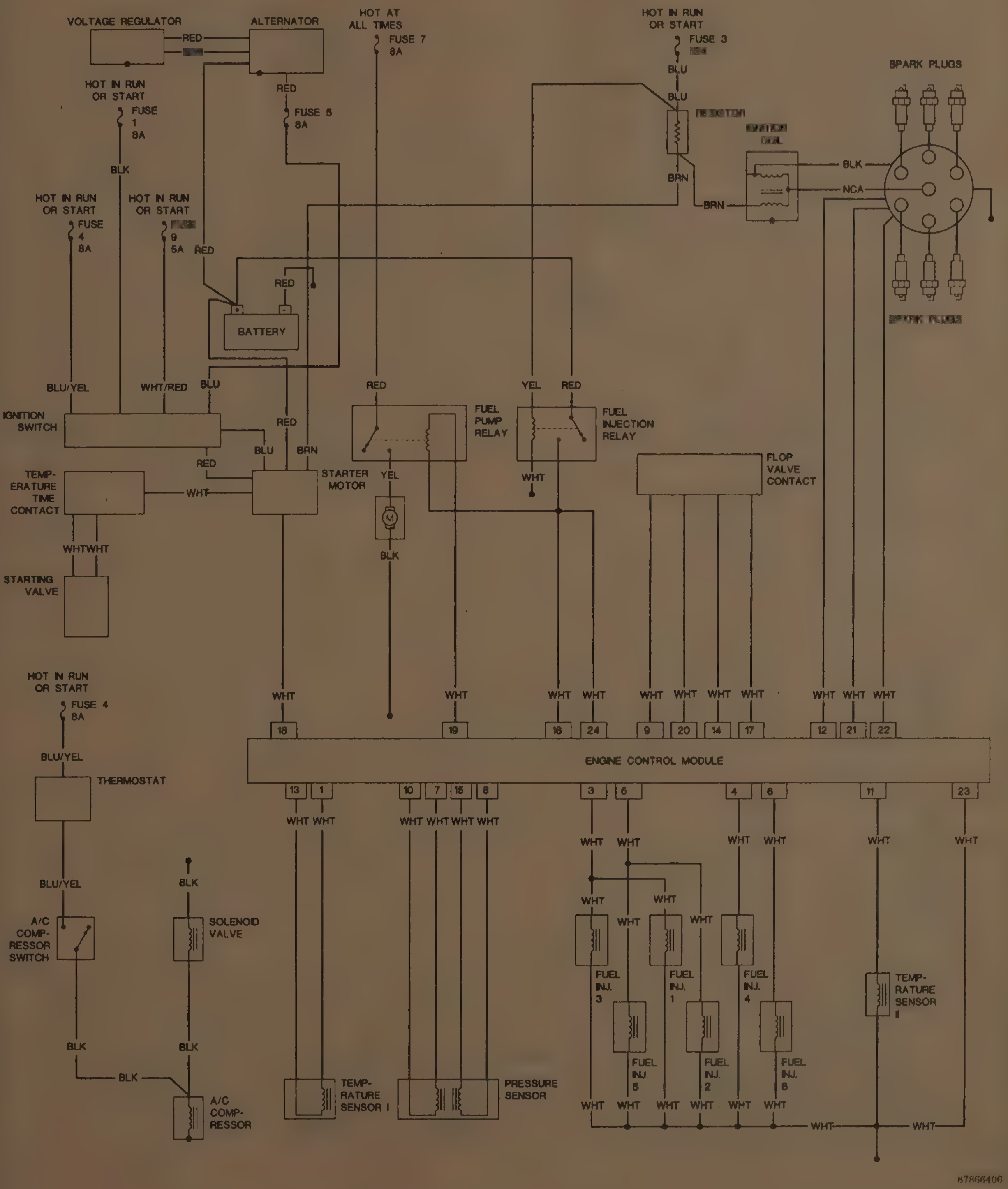

VOLTAGE REGULATOR
RED
ALTERNATOR
HOT AT ALL TIMES
FUSE 7 8A
HOT IN RUN OR START
FUSE 3
BLU
BLU
RESISTOR
IGNITION COIL
BRN
BRN
SPARK PLUGS
BLK
NCA
HOT IN RUN OR START
FUSE 1 8A
RED
FUSE 5 8A
BLK
HOT IN RUN OR START
FUSE 4 8A
HOT IN RUN OR START
FUSE 9 5A
RED
RED
BATTERY
SPARK PLUGS
BLU/YEL
WHT/RED
BLU
RED
YEL
RED
IGNITION SWITCH
RED
FUEL PUMP RELAY
FUEL INJECTION RELAY
BLU
BRN
RED
STARTER MOTOR
YEL
WHT
FLOP VALVE CONTACT
TEMPERATURE TIME CONTACT
WHT
M
BLK
WHTWHT
STARTING VALVE
HOT IN RUN OR START
FUSE 4 8A
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
18
19
16
24
9
20
14
17
12
21
22
BLU/YEL
ENGINE CONTROL MODULE
THERMOSTAT
13
1
10
7
15
8
3
6
4
8
11
23
WHT WHT
WHT WHT WHT WHT
WHT
WHT
WHT
WHT
WHT
WHT
BLU/YEL
BLK
WHT
WHT
WHT
WHT
A/C COMPRESSOR SWITCH
SOLENOID VALVE
FUEL INJ. 3
FUEL INJ. 1
FUEL INJ. 4
TEMPERATURE SENSOR II
FUEL INJ. 5
FUEL INJ. 2
FUEL INJ. 6
BLK
BLK
BLK
TEMPRATURE SENSOR I
PRESSURE SENSOR
WHT WHT WHT WHT WHT WHT
WHT
WHT
A/C COMPRESSOR
87866406

Fig. 91 Engine wiring — 1973-75 160 series

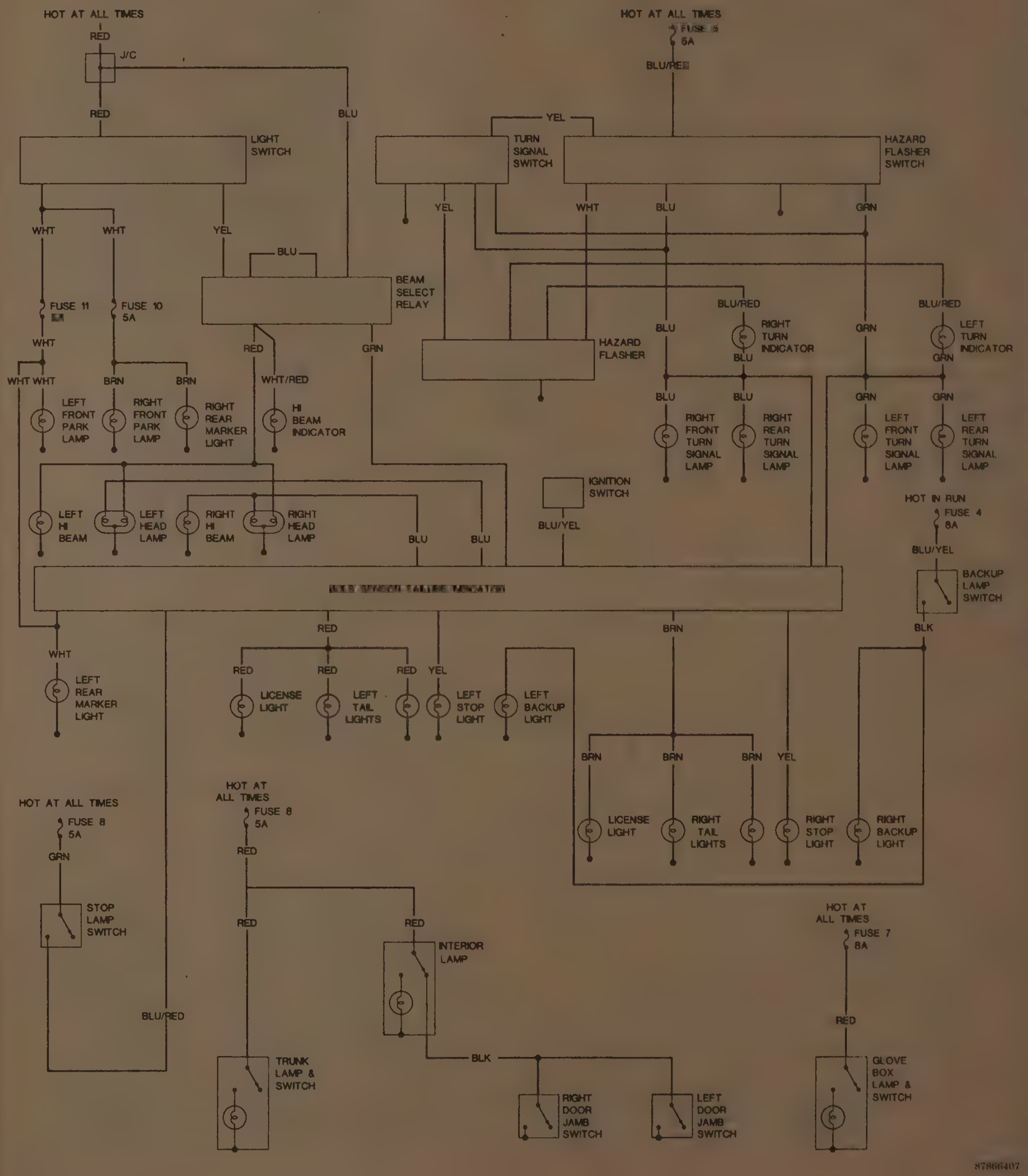

HOT AT ALL TIMES
RED
J/C
RED
BLU
LIGHT SWITCH
WHT
WHT
YEL
BLU
BEAM SELECT RELAY
FUSE 11 5A
FUSE 10 5A
WHT
WHT WHT
BRN
BRN
RED
WHT/RED
GRN
LEFT FRONT PARK LAMP
RIGHT FRONT PARK LAMP
RIGHT REAR MARKER LIGHT
HI BEAM INDICATOR
LEFT HI BEAM
LEFT HEAD LAMP
RIGHT HI BEAM
RIGHT HEAD LAMP
BLU
BLU
HOT AT ALL TIMES
FUSE 5 5A
BLU/RED
YEL
TURN SIGNAL SWITCH
HAZARD FLASHER SWITCH
YEL
WHT
BLU
GRN
HAZARD FLASHER
BLU/RED
BLU/RED
BLU
RIGHT TURN INDICATOR
BLU
GRN
LEFT TURN INDICATOR
GRN
BLU
BLU
GRN
GRN
RIGHT FRONT TURN SIGNAL LAMP
RIGHT REAR TURN SIGNAL LAMP
LEFT FRONT TURN SIGNAL LAMP
LEFT REAR TURN SIGNAL LAMP
IGNITION SWITCH
BLU/YEL
HOT IN RUN
FUSE 4 8A
BLU/YEL
BACKUP LAMP SWITCH
BLK
BULB SENSOR FAILURE INDICATOR
WHT
LEFT REAR MARKER LIGHT
RED
RED
RED
RED
YEL
LICENSE LIGHT
LEFT TAIL LIGHTS
LEFT STOP LIGHT
LEFT BACKUP LIGHT
BRN
BRN
BRN
BRN
YEL
LICENSE LIGHT
RIGHT TAIL LIGHTS
RIGHT STOP LIGHT
RIGHT BACKUP LIGHT
HOT AT ALL TIMES
FUSE 8 5A
GRN
STOP LAMP SWITCH
BLU/RED
HOT AT ALL TIMES
FUSE 8 5A
RED
RED
RED
INTERIOR LAMP
TRUNK LAMP & SWITCH
BLK
RIGHT DOOR JAMB SWITCH
LEFT DOOR JAMB SWITCH
HOT AT ALL TIMES
FUSE 7 8A
RED
GLOVE BOX LAMP & SWITCH
87866407

Fig. 92 Chassis wiring — 1974-75 160 series

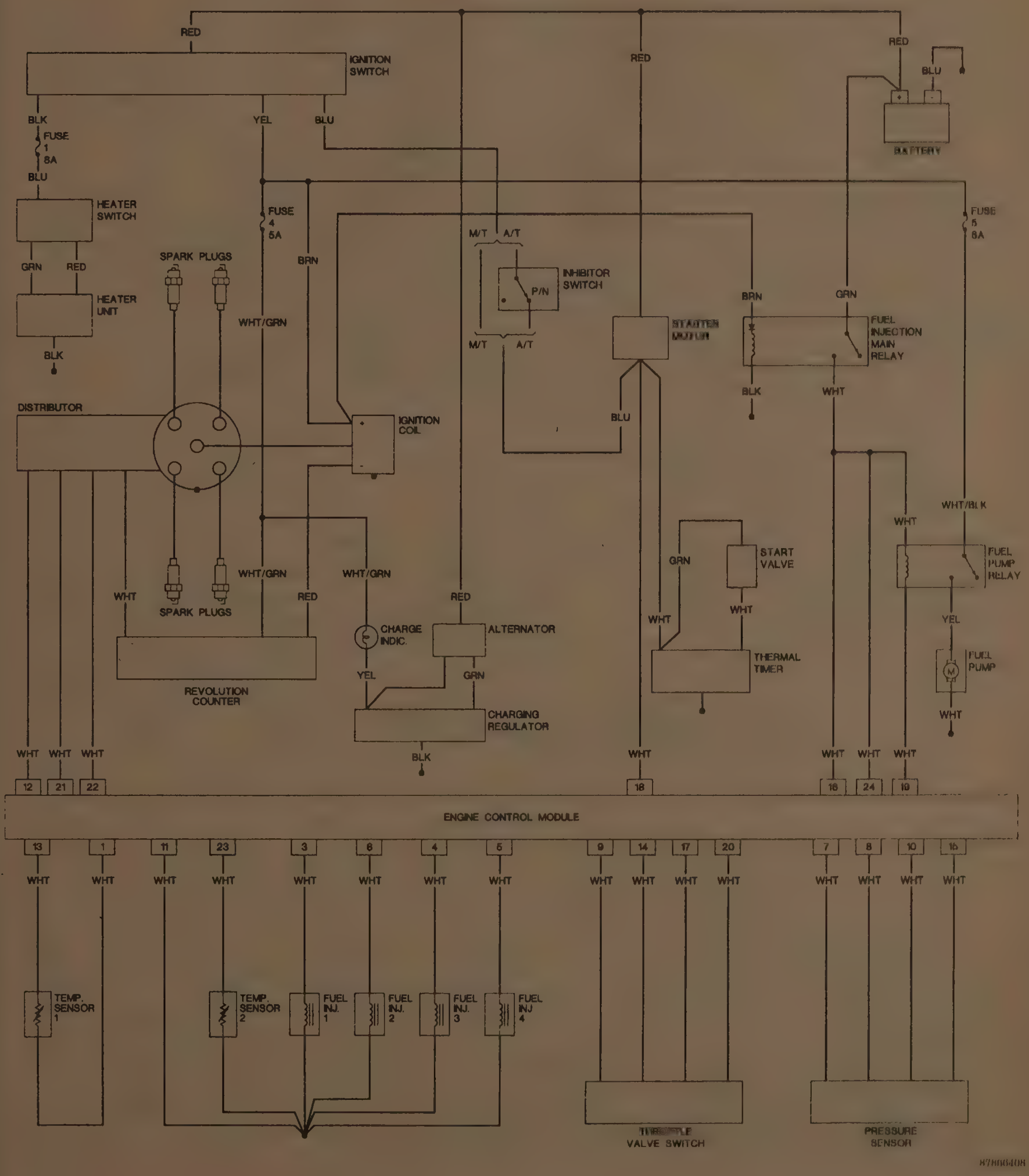

RED
IGNITION SWITCH
RED
RED
BLU
BATTERY
BLK
FUSE 1 8A
BLU
YEL
BLU
HEATER SWITCH
FUSE 4 5A
FUSE 5 8A
GRN
RED
SPARK PLUGS
BRN
M/T
A/T
INHIBITOR SWITCH
P/N
HEATER UNIT
WHT/GRN
M/T
A/T
STARTER MOTOR
BRN
GRN
FUEL INJECTION MAIN RELAY
BLK
BLK
WHT
DISTRIBUTOR
IGNITION COIL
BLU
WHT/BLK
WHT
START VALVE
GRN
FUEL PUMP RELAY
WHT/GRN
WHT/GRN
WHT
RED
RED
SPARK PLUGS
CHARGE INDIC.
ALTERNATOR
WHT
WHT
YEL
THERMAL TIMER
FUEL PUMP
YEL
GRN
REVOLUTION COUNTER
CHARGING REGULATOR
WHT
BLK
WHT
WHT
WHT
WHT
WHT
WHT
WHT
12
21
22
18
16
24
19
ENGINE CONTROL MODULE
13
1
11
23
3
6
4
5
9
14
17
20
7
8
10
15
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
WHT
TEMP. SENSOR 1
TEMP. SENSOR 2
FUEL INJ. 1
FUEL INJ. 2
FUEL INJ. 3
FUEL INJ 4
THROTTLE VALVE SWITCH
PRESSURE SENSOR
87666408

Fig. 93 Engine wiring — 1970-73 1800

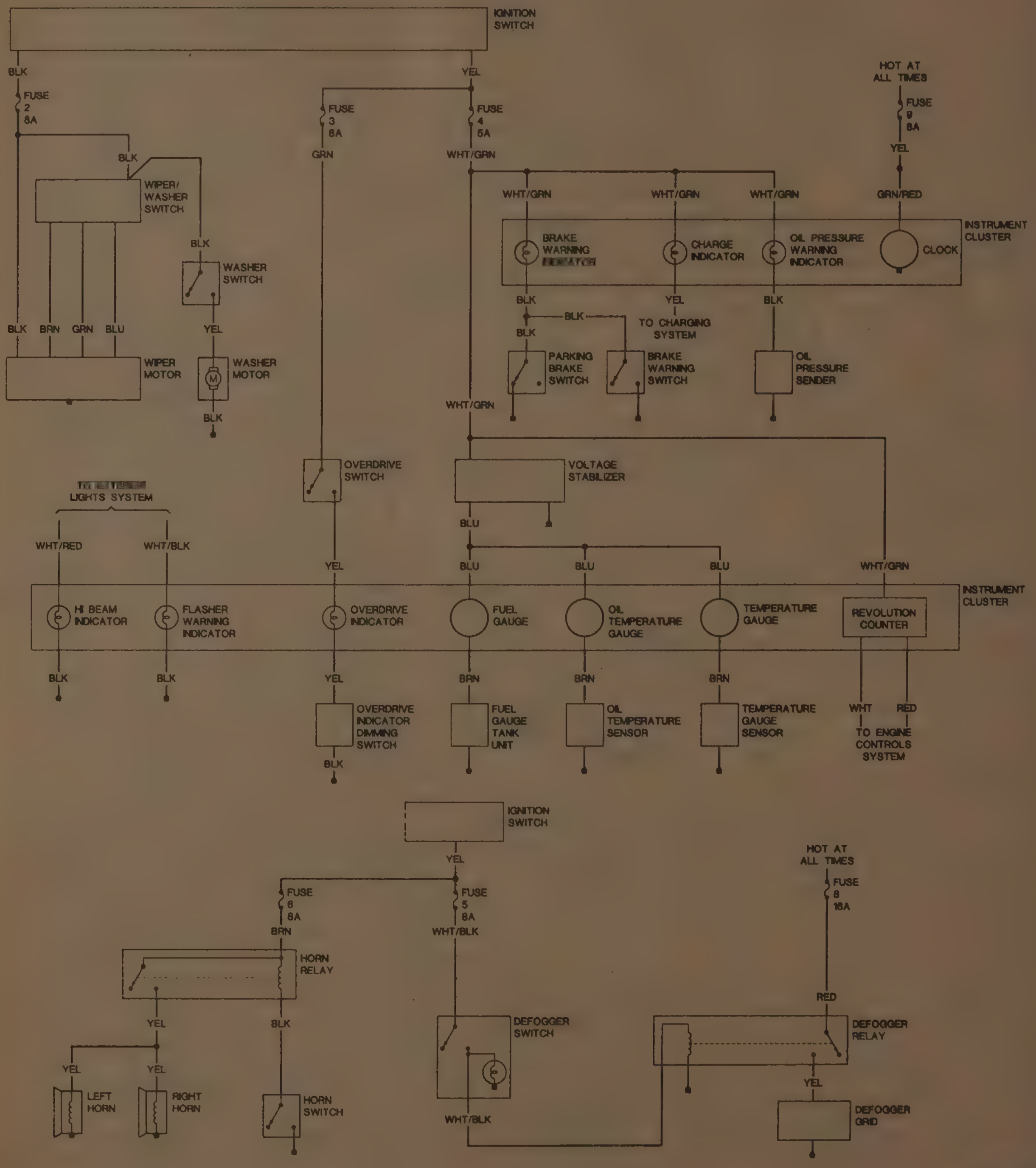

IGNITION SWITCH
BLK
YEL
FUSE 2 8A
FUSE 3 8A
FUSE 4 5A
HOT AT ALL TIMES
FUSE 9 8A
YEL
GRN
WHT/GRN
BLK
WIPER/ WASHER SWITCH
WHT/GRN
WHT/GRN
WHT/GRN
GRN/RED
INSTRUMENT CLUSTER
BRAKE WARNING INDICATOR
CHARGE INDICATOR
OIL PRESSURE WARNING INDICATOR
CLOCK
BLK
WASHER SWITCH
BLK
YEL
BLK
BLK
TO CHARGING SYSTEM
BLK
BLK BRN GRN BLU
YEL
WIPER MOTOR
WASHER MOTOR
PARKING BRAKE SWITCH
BRAKE WARNING SWITCH
OIL PRESSURE SENDER
BLK
WHT/GRN
OVERDRIVE SWITCH
VOLTAGE STABILIZER
TO EXTERIOR LIGHTS SYSTEM
BLU
WHT/RED
WHT/BLK
YEL
BLU
BLU
BLU
WHT/GRN
INSTRUMENT CLUSTER
HI BEAM INDICATOR
FLASHER WARNING INDICATOR
OVERDRIVE INDICATOR
FUEL GAUGE
OIL TEMPERATURE GAUGE
TEMPERATURE GAUGE
REVOLUTION COUNTER
BLK
BLK
YEL
BRN
BRN
BRN
WHT
RED
OVERDRIVE INDICATOR DIMMING SWITCH
FUEL GAUGE TANK UNIT
OIL TEMPERATURE SENSOR
TEMPERATURE GAUGE SENSOR
TO ENGINE CONTROLS SYSTEM
BLK
IGNITION SWITCH
YEL
HOT AT ALL TIMES
FUSE 6 8A
FUSE 5 8A
FUSE 8 16A
BRN
WHT/BLK
HORN RELAY
RED
YEL
BLK
DEFOGGER SWITCH
DEFOGGER RELAY
YEL
YEL
YEL
LEFT HORN
RIGHT HORN
HORN SWITCH
WHT/BLK
DEFOGGER GRID
87866409

Fig. 94 Chassis wiring — 1970-73 1800

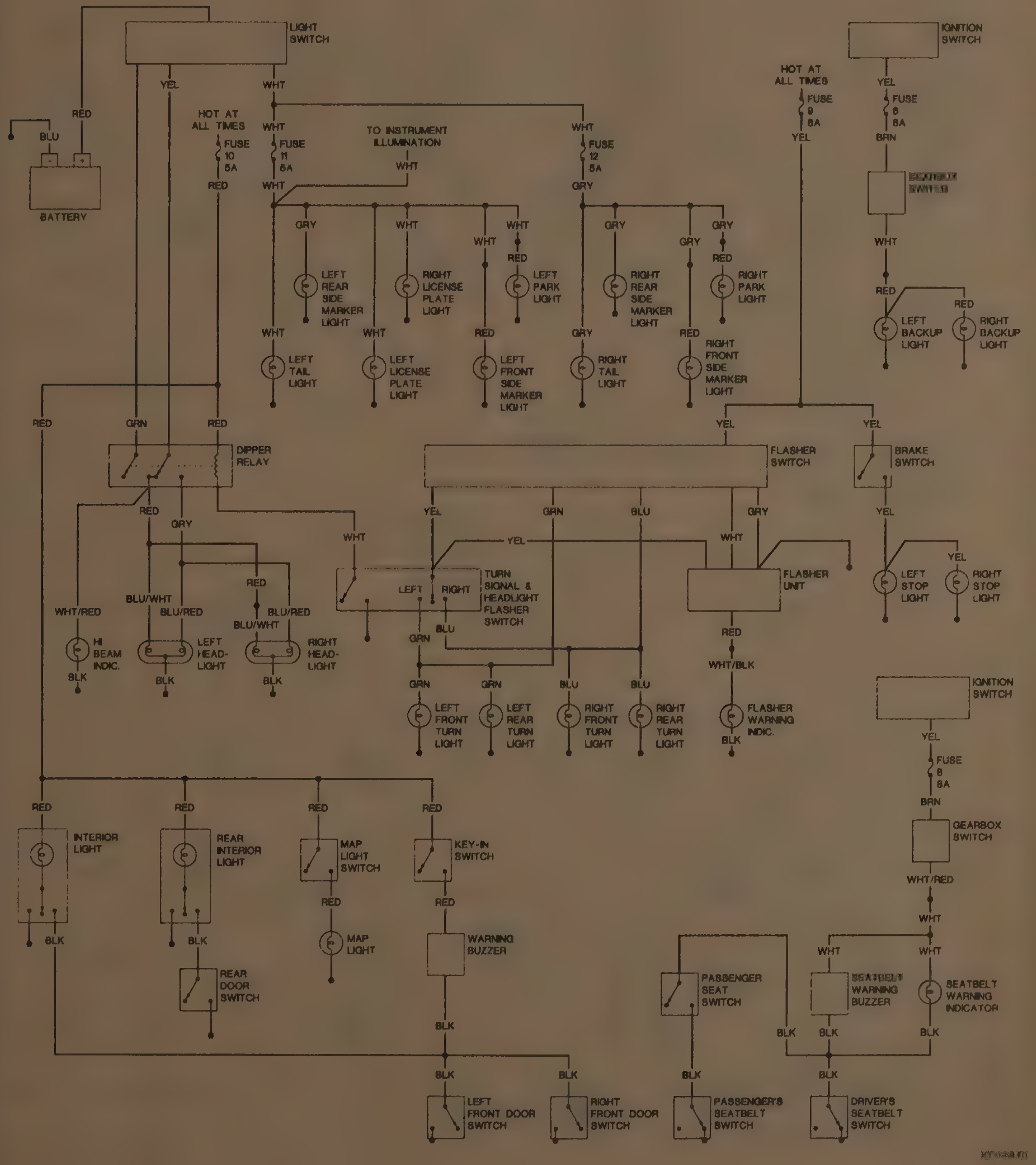

LIGHT SWITCH
BATTERY
BLU
RED
YEL
WHT
HOT AT ALL TIMES
FUSE 10 5A
FUSE 11 5A
FUSE 12 5A
TO INSTRUMENT ILLUMINATION
GRY
LEFT REAR SIDE MARKER LIGHT
RIGHT LICENSE PLATE LIGHT
LEFT PARK LIGHT
RIGHT REAR SIDE MARKER LIGHT
RIGHT PARK LIGHT
LEFT TAIL LIGHT
LEFT LICENSE PLATE LIGHT
LEFT FRONT SIDE MARKER LIGHT
RIGHT TAIL LIGHT
RIGHT FRONT SIDE MARKER LIGHT
IGNITION SWITCH
HOT AT ALL TIMES
FUSE 9 5A
FUSE 8 8A
BRN
GEARBOX SWITCH
LEFT BACKUP LIGHT
RIGHT BACKUP LIGHT
GRN
DIPPER RELAY
FLASHER SWITCH
BRAKE SWITCH
BLU
WHT/RED
BLU/WHT
BLU/RED
HI BEAM INDIC.
LEFT HEAD-LIGHT
RIGHT HEAD-LIGHT
BLK
TURN SIGNAL & HEADLIGHT FLASHER SWITCH
LEFT
RIGHT
FLASHER UNIT
LEFT STOP LIGHT
RIGHT STOP LIGHT
WHT/BLK
LEFT FRONT TURN LIGHT
LEFT REAR TURN LIGHT
RIGHT FRONT TURN LIGHT
RIGHT REAR TURN LIGHT
FLASHER WARNING INDIC.
IGNITION SWITCH
FUSE 8 8A
GEARBOX SWITCH
INTERIOR LIGHT
REAR INTERIOR LIGHT
MAP LIGHT SWITCH
KEY-IN SWITCH
MAP LIGHT
WARNING BUZZER
REAR DOOR SWITCH
PASSENGER SEAT SWITCH
SEATBELT WARNING BUZZER
SEATBELT WARNING INDICATOR
LEFT FRONT DOOR SWITCH
RIGHT FRONT DOOR SWITCH
PASSENGER'S SEATBELT SWITCH
DRIVER'S SEATBELT SWITCH

Fig. 95 Chassis wiring — 1970-73 1800 (continued)

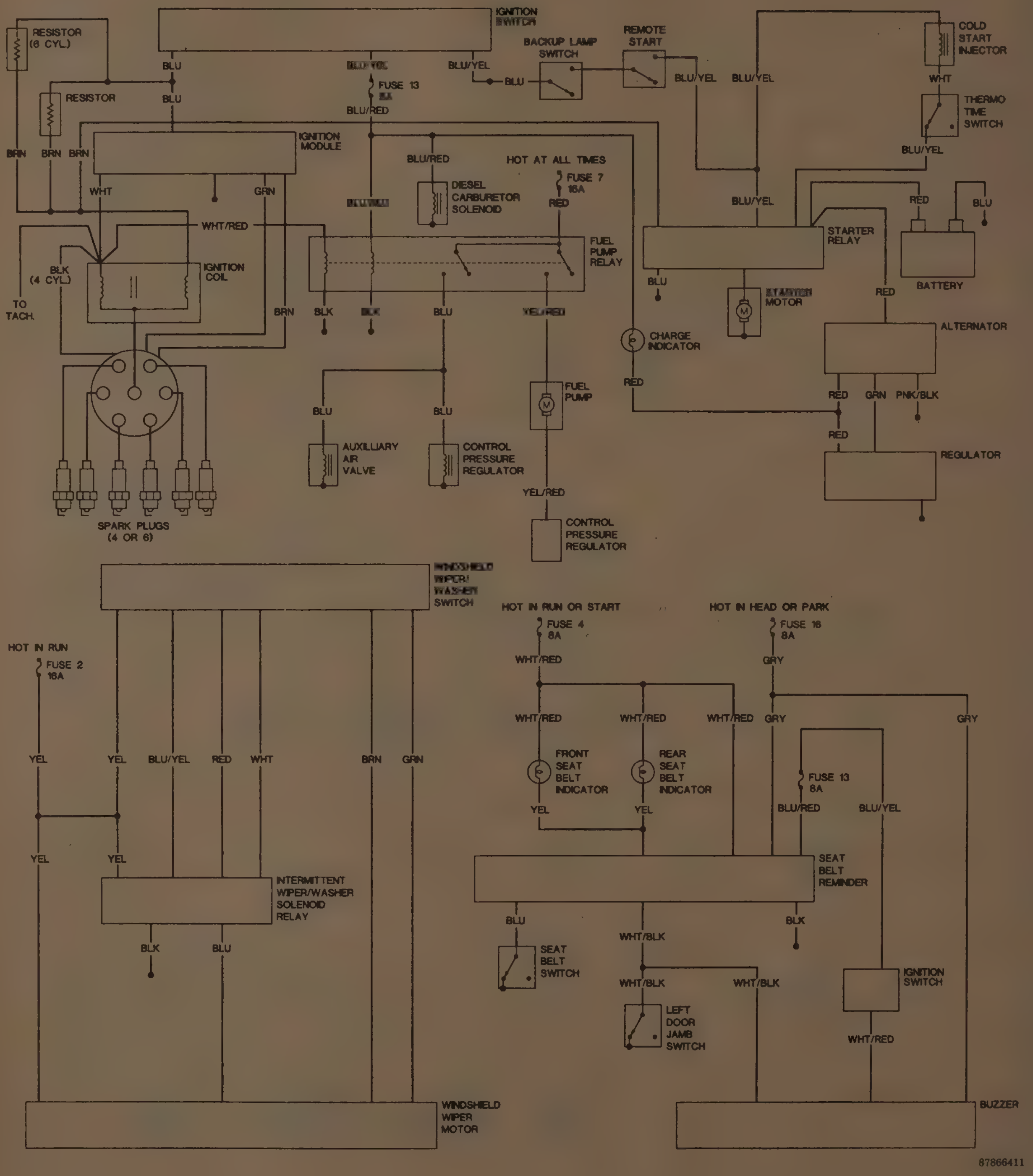

RESISTOR (6 CYL.)
IGNITION SWITCH
BLU
BLU/YEL
BLU/YEL
FUSE 13 8A
BLU
BACKUP LAMP SWITCH
REMOTE START
COLD START INJECTOR
RESISTOR
BLU
BLU/RED
BLU/YEL
BLU/YEL
WHT
THERMO TIME SWITCH
BRN
BRN
BRN
IGNITION MODULE
BLU/RED
HOT AT ALL TIMES
BLU/YEL
WHT
GRN
DIESEL CARBURETOR SOLENOID
FUSE 7 16A
BLU/RED
RED
BLU/YEL
RED
BLU
WHT/RED
FUEL PUMP RELAY
STARTER RELAY
BLK (4 CYL.)
IGNITION COIL
BATTERY
BLU
TO TACH.
BRN
BLK
BLK
BLU
YEL/RED
STARTER MOTOR
RED
CHARGE INDICATOR
ALTERNATOR
FUEL PUMP
RED
RED
GRN
PNK/BLK
BLU
BLU
RED
AUXILLIARY AIR VALVE
CONTROL PRESSURE REGULATOR
REGULATOR
YEL/RED
SPARK PLUGS (4 OR 6)
CONTROL PRESSURE REGULATOR
WINDSHIELD WIPER/ WASHER SWITCH
HOT IN RUN OR START
HOT IN HEAD OR PARK
FUSE 4 8A
FUSE 16 8A
HOT IN RUN
FUSE 2 16A
WHT/RED
GRY
WHT/RED
WHT/RED
WHT/RED
GRY
GRY
YEL
YEL
BLU/YEL
RED
WHT
BRN
GRN
FRONT SEAT BELT INDICATOR
REAR SEAT BELT INDICATOR
FUSE 13 8A
YEL
YEL
BLU/RED
BLU/YEL
YEL
YEL
INTERMITTENT WIPER/WASHER SOLENOID RELAY
SEAT BELT REMINDER
BLU
BLK
BLK
BLU
WHT/BLK
SEAT BELT SWITCH
WHT/BLK
WHT/BLK
IGNITION SWITCH
LEFT DOOR JAMB SWITCH
WHT/RED
WINDSHIELD WIPER MOTOR
BUZZER
87866411

Fig. 96 Engine and chassis wiring — 1975-79 240 series

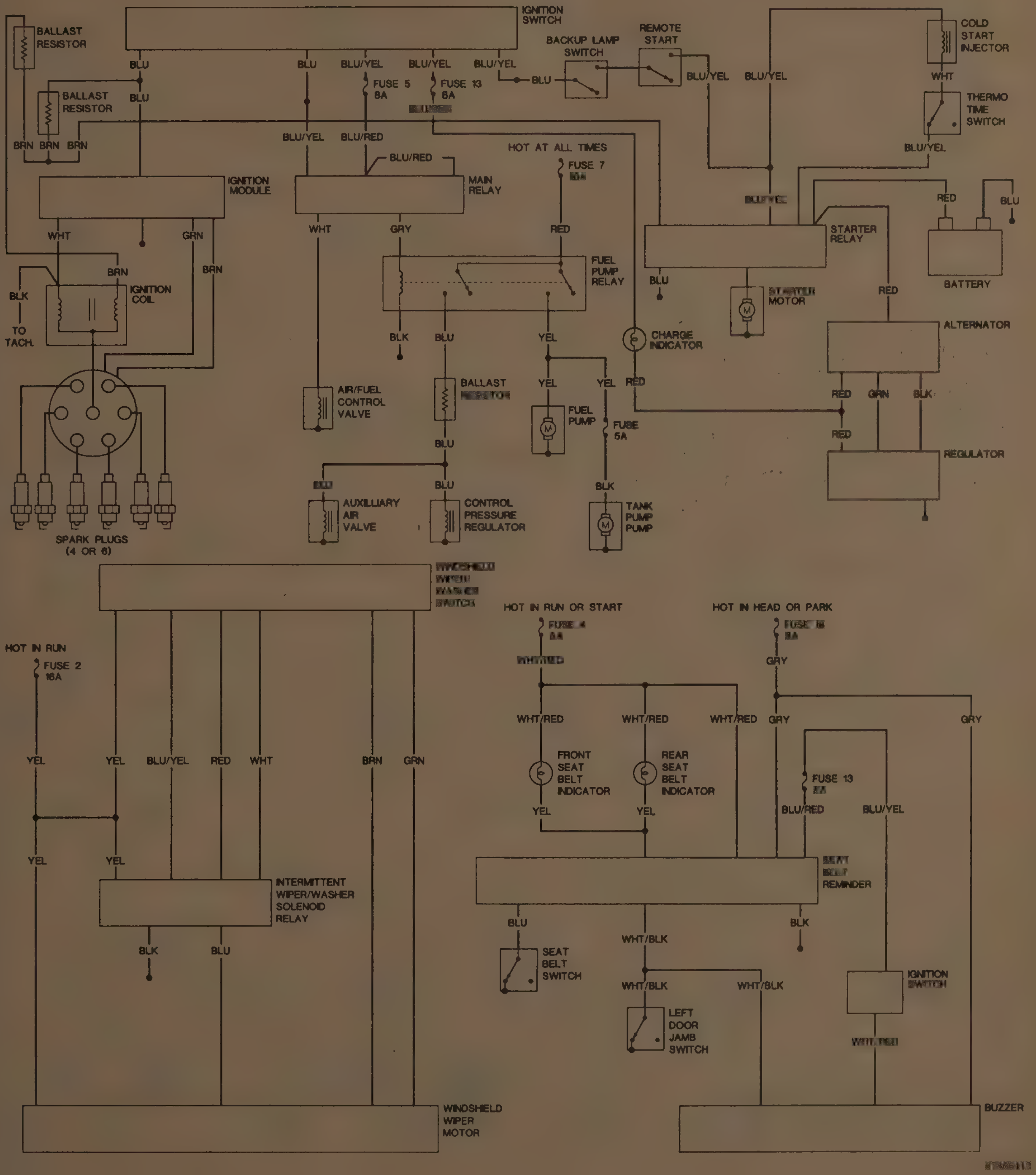

IGNITION SWITCH
BALLAST RESISTOR
BALLAST RESISTOR
BLU
BLU/YEL
FUSE 5 8A
FUSE 13 8A
BACKUP LAMP SWITCH
REMOTE START
COLD START INJECTOR
WHT
THERMO TIME SWITCH
BRN BRN BRN
BLU/YEL
BLU/RED
HOT AT ALL TIMES
FUSE 7
IGNITION MODULE
MAIN RELAY
WHT
GRN
GRY
RED
STARTER RELAY
BATTERY
BRN
IGNITION COIL
BLK
TO TACH.
FUEL PUMP RELAY
STARTER MOTOR
CHARGE INDICATOR
ALTERNATOR
AIR/FUEL CONTROL VALVE
BALLAST
YEL
FUEL PUMP
FUSE 5A
REGULATOR
AUXILIARY AIR VALVE
CONTROL PRESSURE REGULATOR
TANK PUMP PUMP
SPARK PLUGS (4 OR 6)
HOT IN RUN OR START
HOT IN HEAD OR PARK
HOT IN RUN
FUSE 2 16A
WHT/RED
FRONT SEAT BELT INDICATOR
REAR SEAT BELT INDICATOR
FUSE 13
INTERMITTENT WIPER/WASHER SOLENOID RELAY
REMINDER
SEAT BELT SWITCH
WHT/BLK
LEFT DOOR JAMB SWITCH
IGNITION
WINDSHIELD WIPER MOTOR
BUZZER

Fig. 97 Engine and chassis wiring — 1975-78 200 series

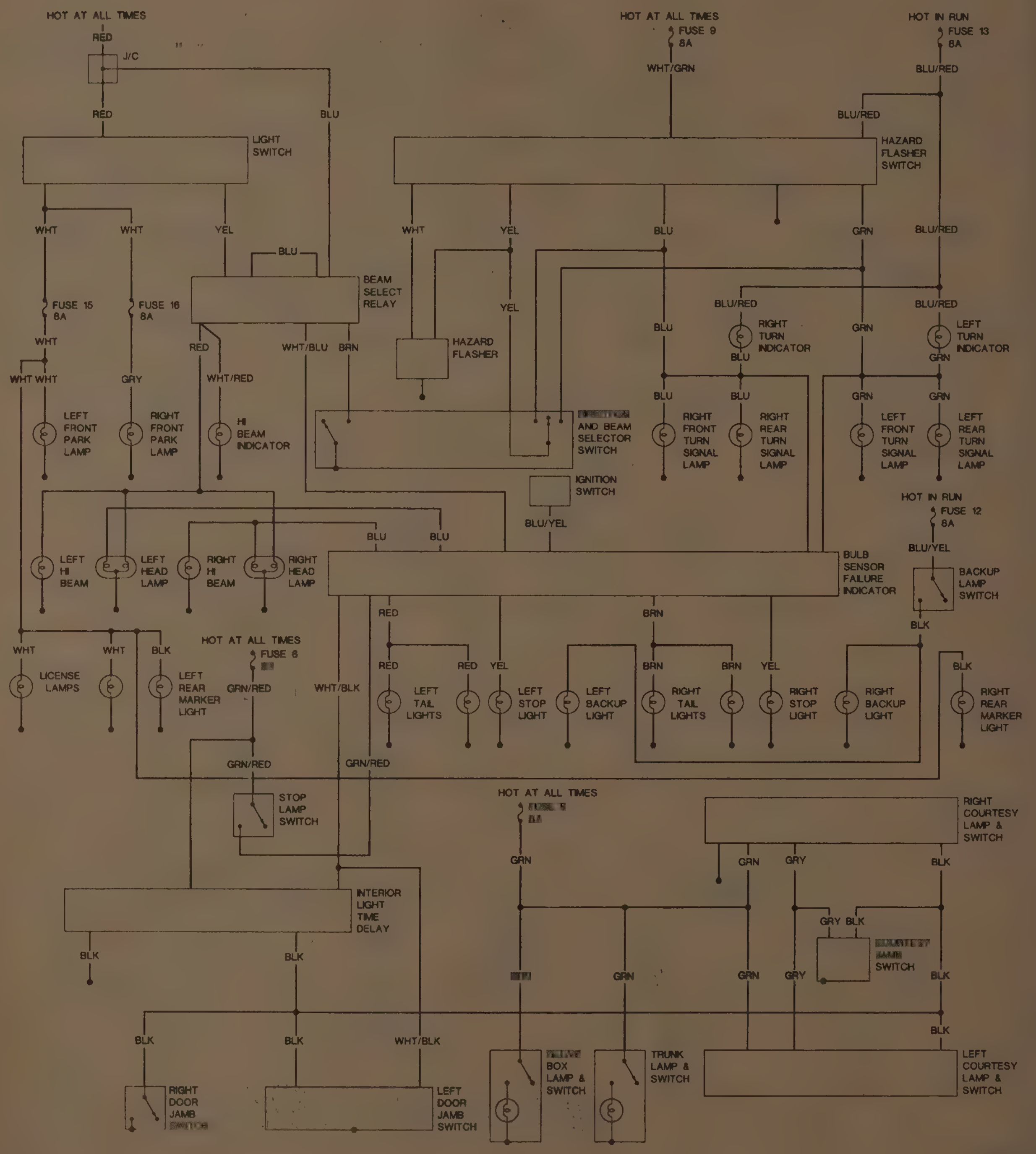

HOT AT ALL TIMES
RED
J/C
RED
BLU
LIGHT SWITCH
WHT
WHT
YEL
BLU
BEAM SELECT RELAY
FUSE 15 8A
FUSE 16 8A
WHT
WHT WHT
GRY
RED
WHT/RED
WHT/BLU
BRN
LEFT FRONT PARK LAMP
RIGHT FRONT PARK LAMP
HI BEAM INDICATOR
HOT AT ALL TIMES
FUSE 9 8A
WHT/GRN
HOT IN RUN
FUSE 13 8A
BLU/RED
BLU/RED
HAZARD FLASHER SWITCH
WHT
YEL
BLU
GRN
BLU/RED
YEL
HAZARD FLASHER
AND BEAM SELECTOR SWITCH
IGNITION SWITCH
BLU/YEL
BLU/RED
RIGHT TURN INDICATOR
BLU
BLU
GRN
BLU/RED
LEFT TURN INDICATOR
GRN
BLU
BLU
GRN
GRN
RIGHT FRONT TURN SIGNAL LAMP
RIGHT REAR TURN SIGNAL LAMP
LEFT FRONT TURN SIGNAL LAMP
LEFT REAR TURN SIGNAL LAMP
HOT IN RUN
FUSE 12 8A
BLU/YEL
BACKUP LAMP SWITCH
BULB SENSOR FAILURE INDICATOR
BLU
BLU
LEFT HI BEAM
LEFT HEAD LAMP
RIGHT HI BEAM
RIGHT HEAD LAMP
WHT
WHT
BLK
LICENSE LAMPS
LEFT REAR MARKER LIGHT
HOT AT ALL TIMES
FUSE 6
GRN/RED
WHT/BLK
RED
RED
RED
YEL
BRN
BRN
BRN
YEL
BLK
BLK
LEFT TAIL LIGHTS
LEFT STOP LIGHT
LEFT BACKUP LIGHT
RIGHT TAIL LIGHTS
RIGHT STOP LIGHT
RIGHT BACKUP LIGHT
RIGHT REAR MARKER LIGHT
GRN/RED
GRN/RED
STOP LAMP SWITCH
HOT AT ALL TIMES
GRN
RIGHT COURTESY LAMP & SWITCH
GRN
GRY
BLK
GRY BLK
SWITCH
INTERIOR LIGHT TIME DELAY
BLK
BLK
GRN
GRN
GRY
BLK
BLK
BLK
BLK
WHT/BLK
RIGHT DOOR JAMB
LEFT DOOR JAMB SWITCH
BOX LAMP & SWITCH
TRUNK LAMP & SWITCH
LEFT COURTESY LAMP & SWITCH
87866413

Fig. 98 Chassis wiring — 1975-79 200 series

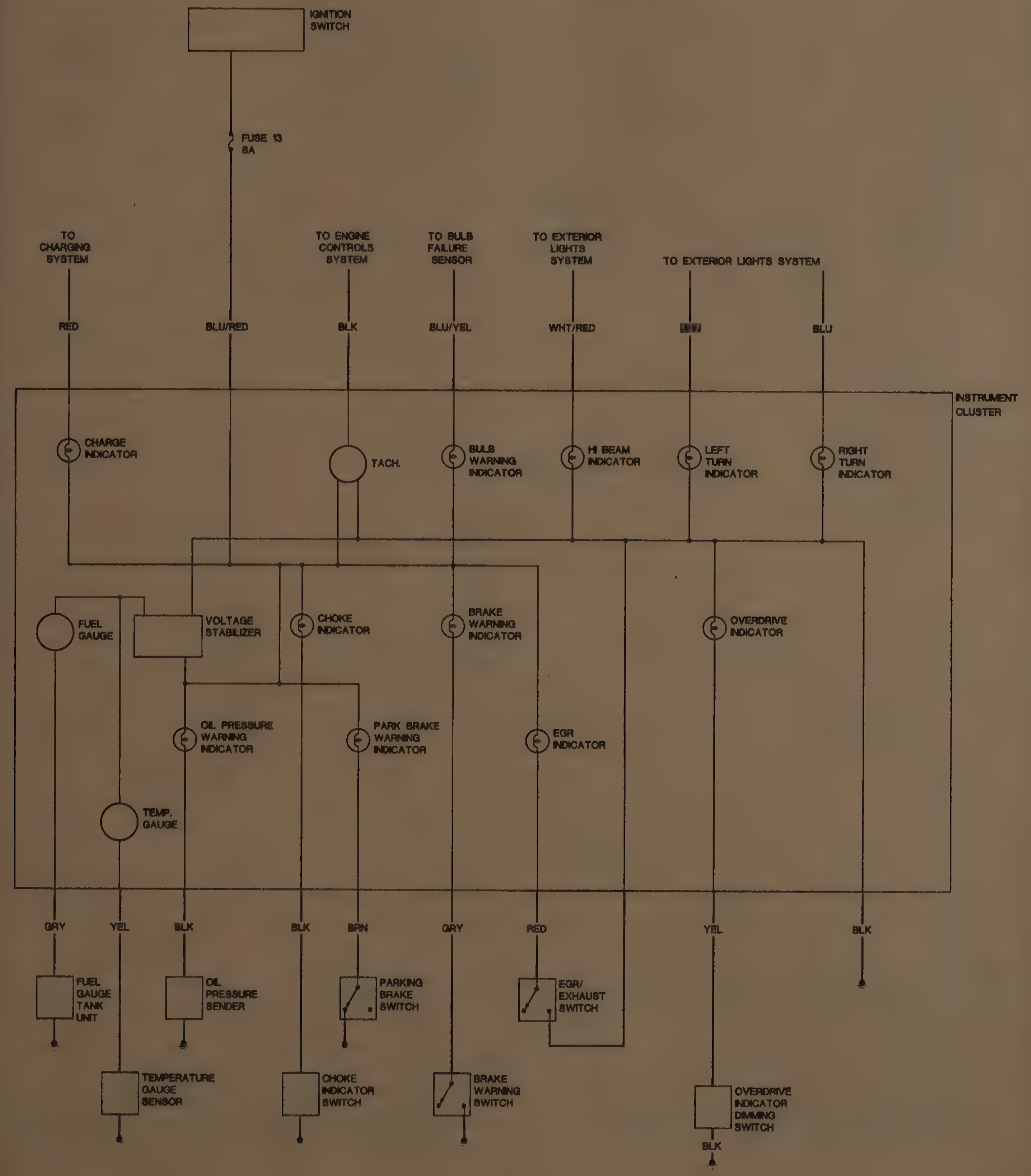

IGNITION SWITCH
FUSE 13 8A
TO CHARGING SYSTEM
TO ENGINE CONTROLS SYSTEM
TO BULB FAILURE SENSOR
TO EXTERIOR LIGHTS SYSTEM
TO EXTERIOR LIGHTS SYSTEM
RED
BLU/RED
BLK
BLU/YEL
WHT/RED
BLU
INSTRUMENT CLUSTER
CHARGE INDICATOR
TACH.
BULB WARNING INDICATOR
HI BEAM INDICATOR
LEFT TURN INDICATOR
RIGHT TURN INDICATOR
FUEL GAUGE
VOLTAGE STABILIZER
CHOKE INDICATOR
BRAKE WARNING INDICATOR
OVERDRIVE INDICATOR
OIL PRESSURE WARNING INDICATOR
PARK BRAKE WARNING INDICATOR
EGR INDICATOR
TEMP. GAUGE
GRY
YEL
BLK
BLK
BRN
GRY
RED
YEL
BLK
FUEL GAUGE TANK UNIT
OIL PRESSURE SENDER
PARKING BRAKE SWITCH
EGR/ EXHAUST SWITCH
TEMPERATURE GAUGE SENSOR
CHOKE INDICATOR SWITCH
BRAKE WARNING SWITCH
OVERDRIVE INDICATOR DIMMING SWITCH
BLK

Fig. 99 Chassis wiring — 1976-79 (all models)

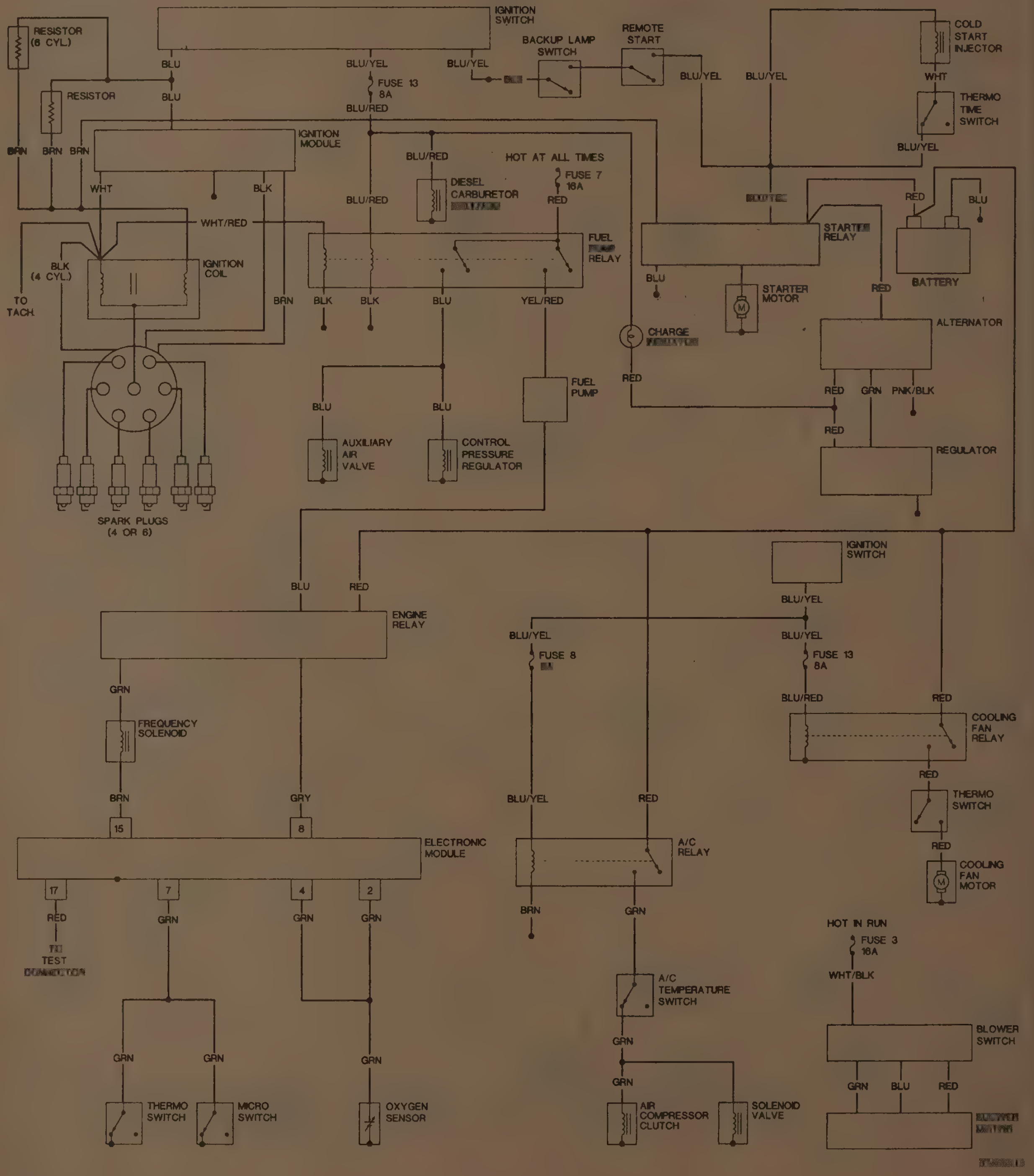

IGNITION SWITCH
RESISTOR (6 CYL.)
RESISTOR
BLU
BLU
BLU/YEL
FUSE 13 8A
BLU/RED
BLU/YEL
BACKUP LAMP SWITCH
REMOTE START
BLU/YEL
BLU/YEL
COLD START INJECTOR
WHT
THERMO TIME SWITCH
BLU/YEL
BRN
BRN
BRN
IGNITION MODULE
BLU/RED
HOT AT ALL TIMES
FUSE 7 16A
RED
DIESEL CARBURETOR
WHT
BLK
BLU/RED
WHT/RED
FUEL RELAY
STARTER RELAY
RED
BLU
BATTERY
BLK (4 CYL.)
IGNITION COIL
TO TACH
BRN
BLK
BLK
BLU
YEL/RED
BLU
STARTER MOTOR
RED
ALTERNATOR
CHARGE
RED
FUEL PUMP
RED
GRN
PNK/BLK
RED
REGULATOR
BLU
BLU
AUXILIARY AIR VALVE
CONTROL PRESSURE REGULATOR
SPARK PLUGS (4 OR 6)
IGNITION SWITCH
BLU/YEL
BLU
RED
ENGINE RELAY
BLU/YEL
FUSE 8
BLU/YEL
FUSE 13 8A
BLU/RED
RED
COOLING FAN RELAY
GRN
FREQUENCY SOLENOID
RED
THERMO SWITCH
BRN
GRY
BLU/YEL
RED
15
8
ELECTRONIC MODULE
A/C RELAY
RED
COOLING FAN MOTOR
17
7
4
2
RED
GRN
GRN
GRN
BRN
GRN
TEST
HOT IN RUN
FUSE 3 16A
WHT/BLK
A/C TEMPERATURE SWITCH
GRN
BLOWER SWITCH
GRN
GRN
GRN
GRN
GRN
BLU
RED
THERMO SWITCH
MICRO SWITCH
OXYGEN SENSOR
AIR COMPRESSOR CLUTCH
SOLENOID VALVE

Fig. 100 Engine and chassis wiring — 200 and 700 series

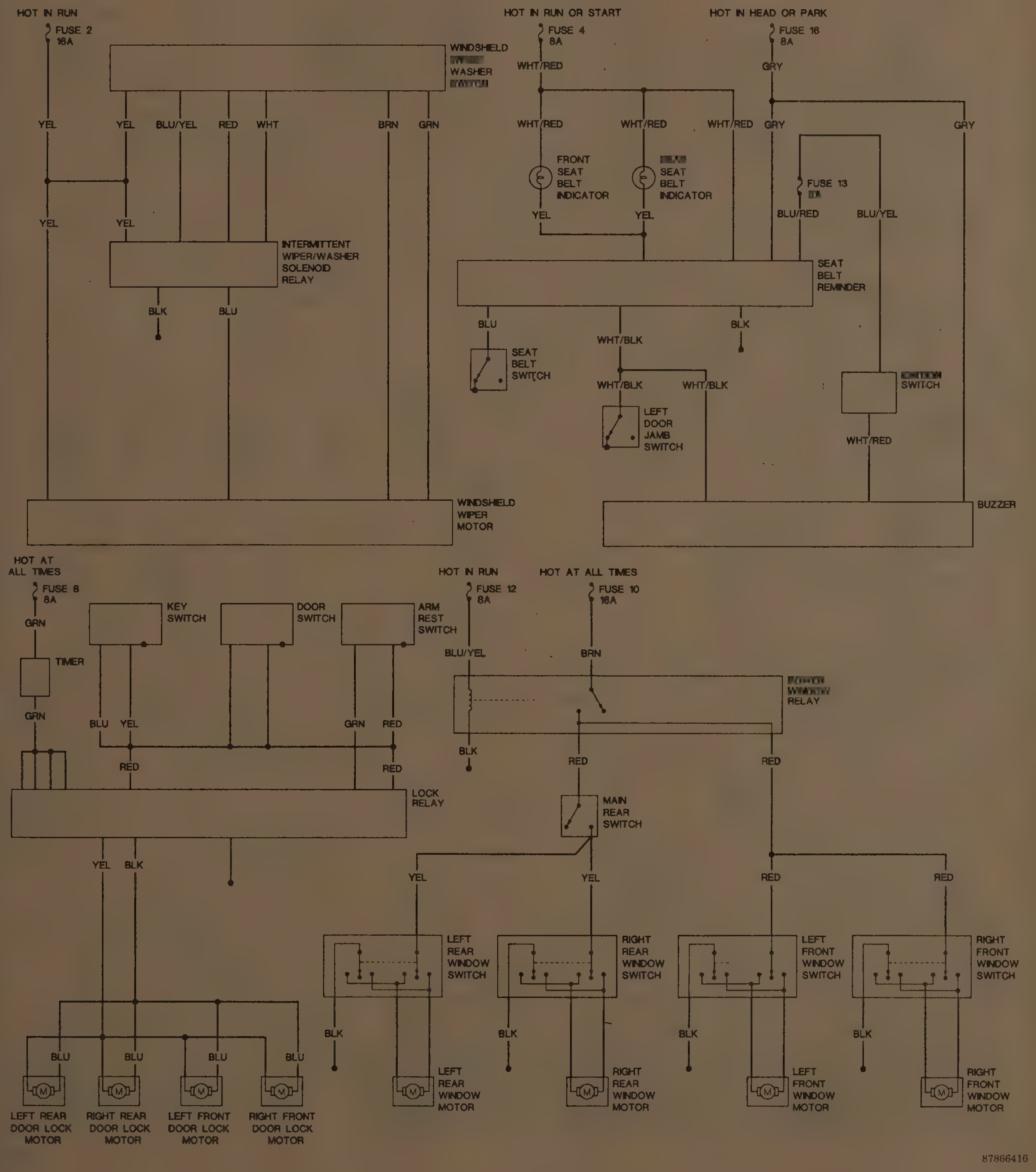

HOT IN RUN
FUSE 2 16A
WINDSHIELD WIPER/WASHER SWITCH
YEL
BLU/YEL
RED
WHT
BRN
GRN
INTERMITTENT WIPER/WASHER SOLENOID RELAY
BLK
BLU
WINDSHIELD WIPER MOTOR
HOT IN RUN OR START
FUSE 4 8A
WHT/RED
FRONT SEAT BELT INDICATOR
REAR SEAT BELT INDICATOR
HOT IN HEAD OR PARK
FUSE 16 8A
GRY
FUSE 13
BLU/RED
BLU/YEL
SEAT BELT REMINDER
SEAT BELT SWITCH
WHT/BLK
LEFT DOOR JAMB SWITCH
IGNITION SWITCH
WHT/RED
BUZZER
HOT AT ALL TIMES
FUSE 8 8A
GRN
TIMER
KEY SWITCH
DOOR SWITCH
ARM REST SWITCH
BLU
YEL
RED
LOCK RELAY
BLK
LEFT REAR DOOR LOCK MOTOR
RIGHT REAR DOOR LOCK MOTOR
LEFT FRONT DOOR LOCK MOTOR
RIGHT FRONT DOOR LOCK MOTOR
HOT IN RUN
FUSE 12 8A
HOT AT ALL TIMES
FUSE 10 16A
POWER WINDOW RELAY
MAIN REAR SWITCH
LEFT REAR WINDOW SWITCH
RIGHT REAR WINDOW SWITCH
LEFT FRONT WINDOW SWITCH
RIGHT FRONT WINDOW SWITCH
LEFT REAR WINDOW MOTOR
RIGHT REAR WINDOW MOTOR
LEFT FRONT WINDOW MOTOR
RIGHT FRONT WINDOW MOTOR
M
87866416

Fig. 101 Chassis wiring — 1980 (all models)

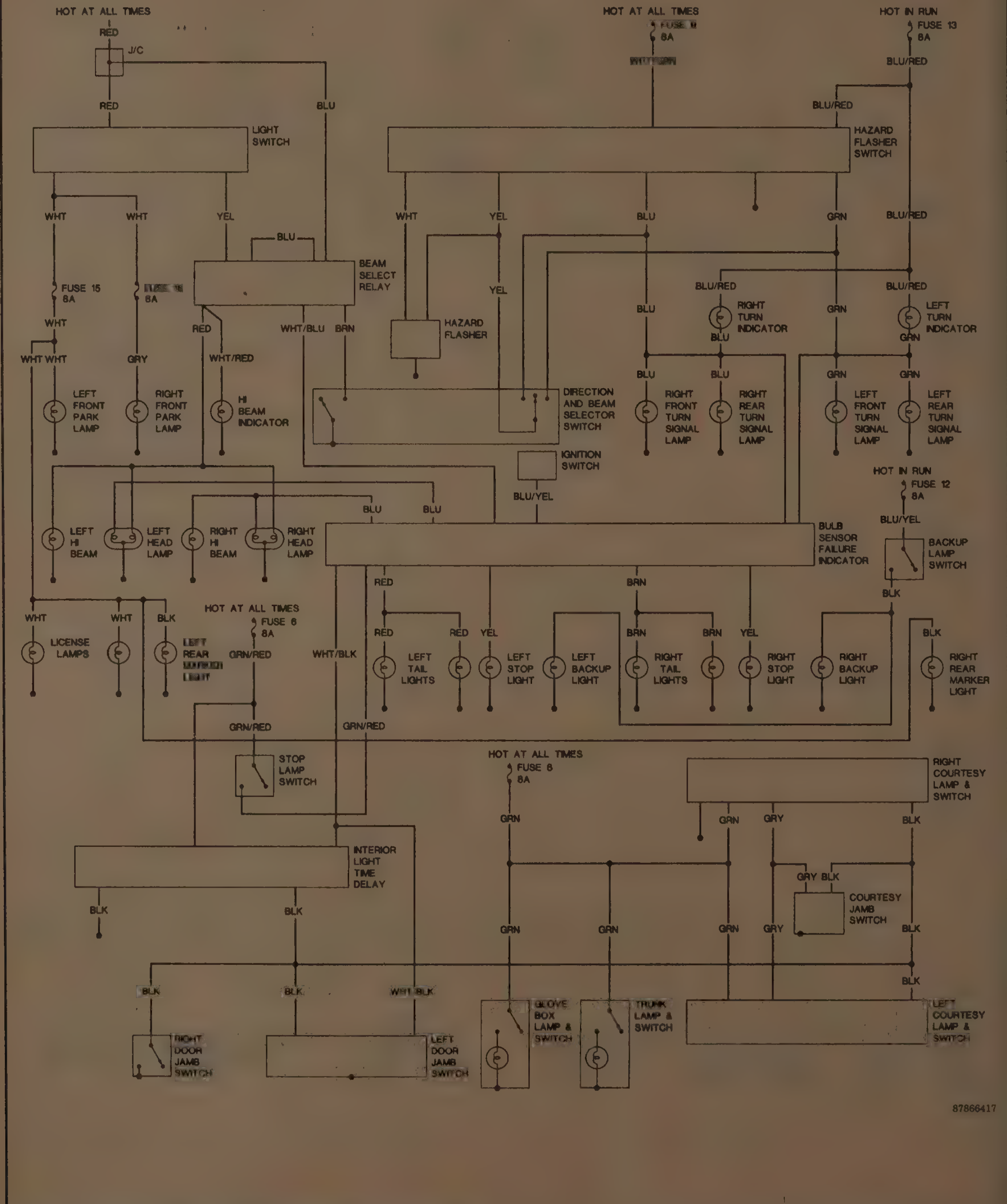

HOT AT ALL TIMES
RED
J/C
RED
BLU
LIGHT SWITCH
HOT AT ALL TIMES
8A
HOT IN RUN
FUSE 13
8A
BLU/RED
BLU/RED
HAZARD FLASHER SWITCH
WHT
WHT
YEL
BLU
BEAM SELECT RELAY
WHT
YEL
BLU
GRN
BLU/RED
FUSE 15
8A
8A
WHT
RED
WHT/BLU
BRN
HAZARD FLASHER
YEL
BLU
BLU/RED
RIGHT TURN INDICATOR
BLU
GRN
BLU/RED
LEFT TURN INDICATOR
GRN
WHT WHT
GRY
WHT/RED
LEFT FRONT PARK LAMP
RIGHT FRONT PARK LAMP
HI BEAM INDICATOR
DIRECTION AND BEAM SELECTOR SWITCH
BLU
BLU
GRN
GRN
RIGHT FRONT TURN SIGNAL LAMP
RIGHT REAR TURN SIGNAL LAMP
LEFT FRONT TURN SIGNAL LAMP
LEFT REAR TURN SIGNAL LAMP
IGNITION SWITCH
HOT IN RUN
FUSE 12
8A
BLU/YEL
BLU
BLU
BLU/YEL
LEFT HI BEAM
LEFT HEAD LAMP
RIGHT HI BEAM
RIGHT HEAD LAMP
BULB SENSOR FAILURE INDICATOR
BACKUP LAMP SWITCH
BLK
RED
BRN
WHT
WHT
BLK
HOT AT ALL TIMES
FUSE 6
8A
LICENSE LAMPS
LEFT REAR MARKER LIGHT
GRN/RED
WHT/BLK
RED
RED
YEL
LEFT TAIL LIGHTS
LEFT STOP LIGHT
LEFT BACKUP LIGHT
BRN
BRN
YEL
RIGHT TAIL LIGHTS
RIGHT STOP LIGHT
RIGHT BACKUP LIGHT
BLK
RIGHT REAR MARKER LIGHT
GRN/RED
GRN/RED
STOP LAMP SWITCH
HOT AT ALL TIMES
FUSE 8
8A
RIGHT COURTESY LAMP & SWITCH
GRN
GRN
GRY
BLK
INTERIOR LIGHT TIME DELAY
GRY BLK
COURTESY JAMB SWITCH
BLK
BLK
GRN
GRN
GRN
GRY
BLK
BLK
BLK
BLK
WHT/BLK
GLOVE BOX LAMP & SWITCH
TRUNK LAMP & SWITCH
LEFT COURTESY LAMP & SWITCH
RIGHT DOOR JAMB SWITCH
LEFT DOOR JAMB SWITCH
87866417

Fig. 102 Chassis wiring — 1980 (all models — continued)

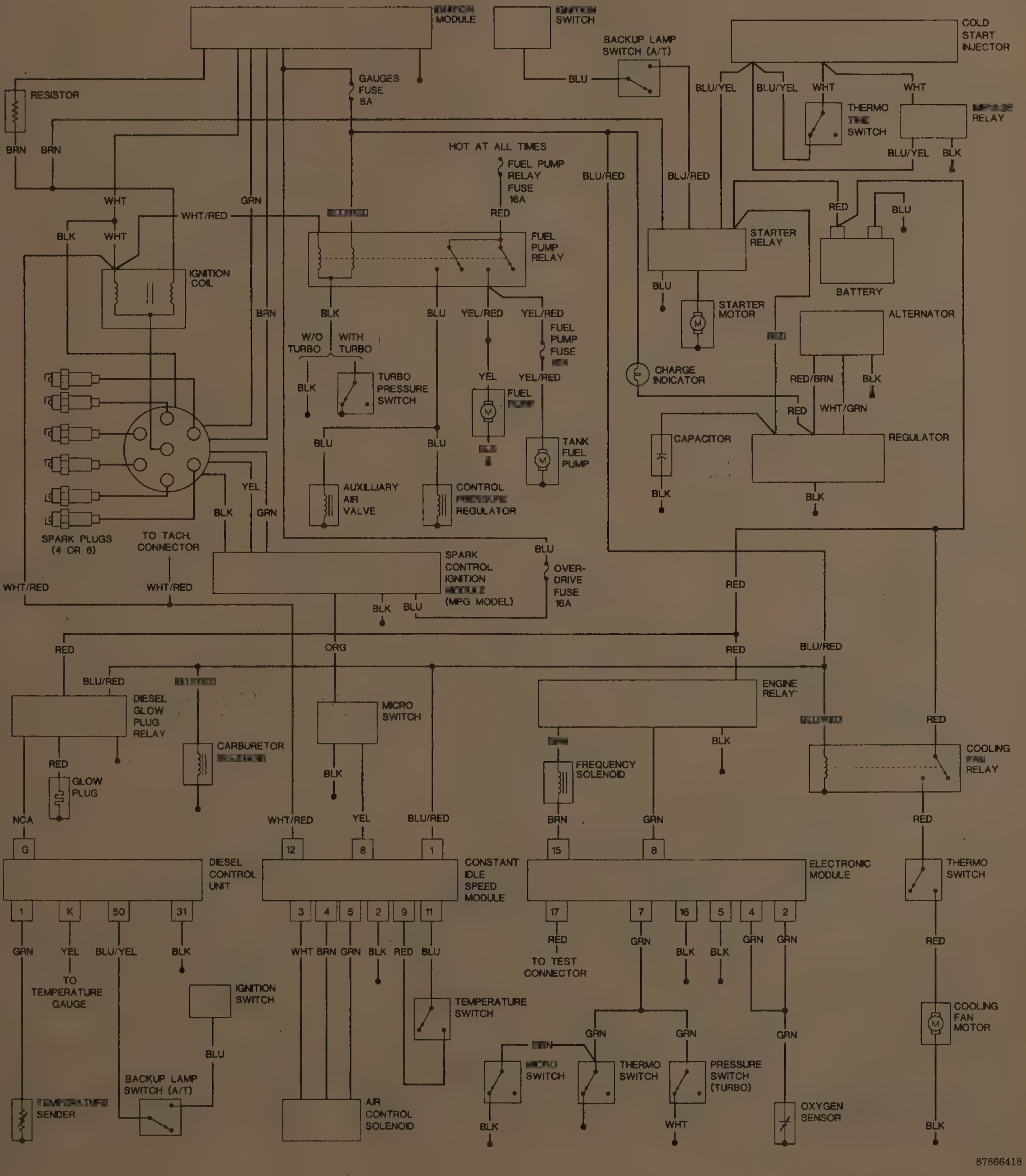

MODULE
SWITCH
BACKUP LAMP SWITCH (A/T)
BLU
COLD START INJECTOR
RESISTOR
GAUGES FUSE 8A
BLU/YEL
BLU/YEL
WHT
WHT
THERMO SWITCH
RELAY
BRN
BRN
HOT AT ALL TIMES
BLU/YEL
BLK
FUEL PUMP RELAY FUSE 16A
BLU/RED
BLU/RED
WHT
GRN
RED
RED
BLU
WHT/RED
BLK
WHT
FUEL PUMP RELAY
STARTER RELAY
IGNITION COIL
BLU
BATTERY
BRN
BLK
BLU
YEL/RED
YEL/RED
STARTER MOTOR
ALTERNATOR
W/O TURBO
WITH TURBO
FUEL PUMP FUSE
TURBO PRESSURE SWITCH
CHARGE INDICATOR
BLK
YEL
YEL/RED
RED/BRN
BLK
FUEL
RED
WHT/GRN
CAPACITOR
REGULATOR
BLU
BLU
TANK FUEL PUMP
YEL
AUXILIARY AIR VALVE
CONTROL REGULATOR
BLK
BLK
BLK
GRN
SPARK PLUGS (4 OR 6)
TO TACH. CONNECTOR
SPARK CONTROL IGNITION (MPG MODEL)
BLU
OVER-DRIVE FUSE 16A
RED
WHT/RED
WHT/RED
BLK
BLU
RED
ORG
RED
BLU/RED
BLU/RED
ENGINE RELAY
DIESEL GLOW PLUG RELAY
MICRO SWITCH
CARBURETOR
RED
BLK
RED
FREQUENCY SOLENOID
COOLING RELAY
RED
GLOW PLUG
BLK
NCA
WHT/RED
YEL
BLU/RED
BRN
GRN
RED
G
12
8
1
15
8
DIESEL CONTROL UNIT
CONSTANT IDLE SPEED MODULE
ELECTRONIC MODULE
THERMO SWITCH
1
K
50
31
3
4
5
2
9
11
17
7
16
5
4
2
GRN
YEL
BLU/YEL
BLK
WHT
BRN
GRN
BLK
RED
BLU
RED
GRN
BLK
BLK
GRN
GRN
RED
TO TEMPERATURE GAUGE
TO TEST CONNECTOR
IGNITION SWITCH
TEMPERATURE SWITCH
COOLING FAN MOTOR
BLU
GRN
GRN
GRN
THERMO SWITCH
PRESSURE SWITCH (TURBO)
BACKUP LAMP SWITCH (A/T)
SWITCH
SENDER
AIR CONTROL SOLENOID
BLK
WHT
OXYGEN SENSOR
BLK
87866418

Fig. 103 Engine and chassis wiring — 1981 200 and 700 series

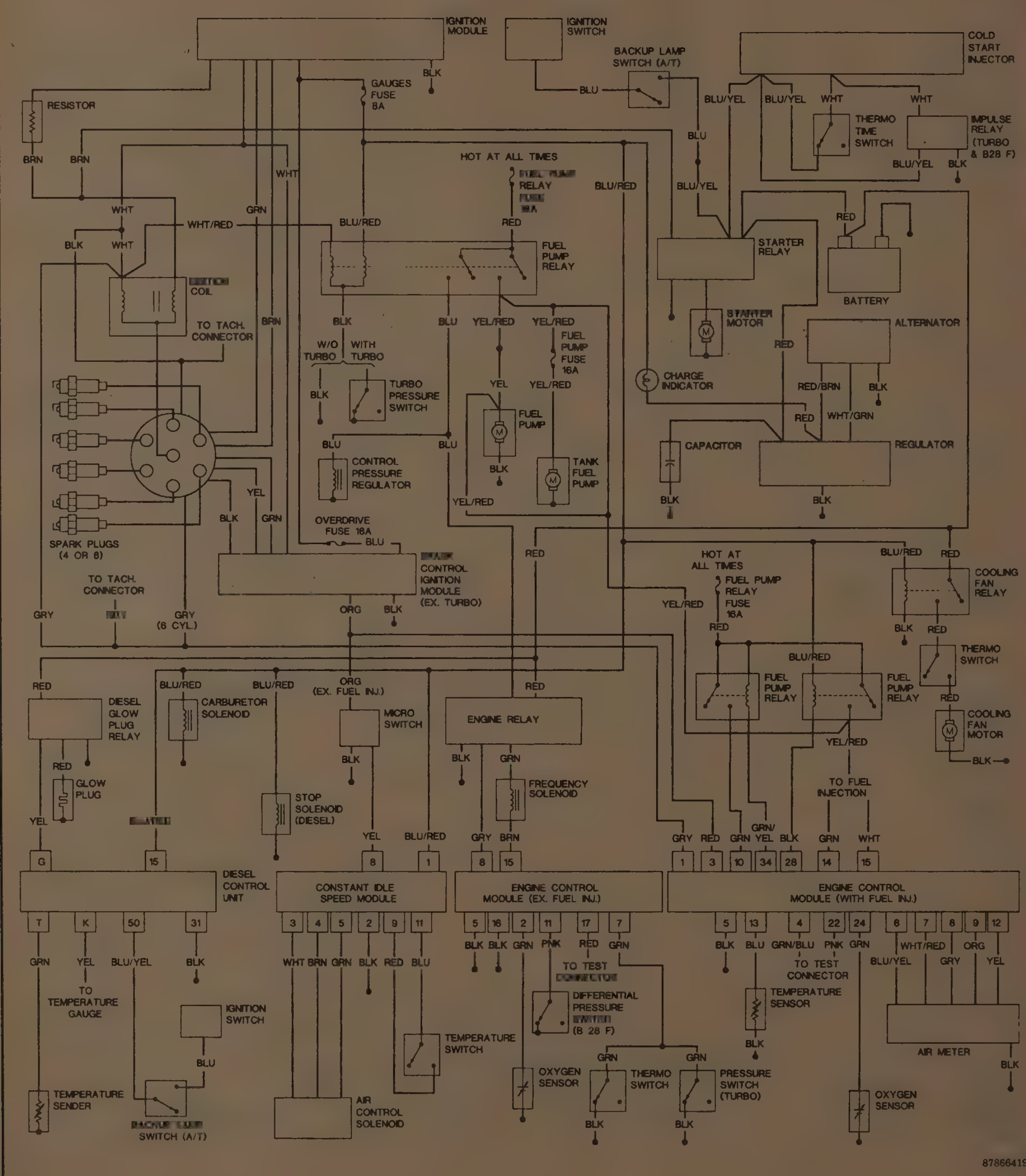

IGNITION MODULE
IGNITION SWITCH
BACKUP LAMP SWITCH (A/T)
COLD START INJECTOR
RESISTOR
GAUGES FUSE 8A
BLK
BLU
BLU/YEL
WHT
THERMO TIME SWITCH
IMPULSE RELAY (TURBO & B28 F)
BRN
WHT
HOT AT ALL TIMES
RELAY
BLU/RED
GRN
WHT/RED
RED
FUEL PUMP RELAY
STARTER RELAY
BATTERY
COIL
TO TACH. CONNECTOR
STARTER MOTOR
ALTERNATOR
W/O TURBO
WITH TURBO
YEL/RED
FUEL PUMP FUSE 16A
TURBO PRESSURE SWITCH
CHARGE INDICATOR
RED/BRN
WHT/GRN
YEL
FUEL PUMP
CAPACITOR
REGULATOR
CONTROL PRESSURE REGULATOR
TANK FUEL PUMP
OVERDRIVE FUSE 16A
SPARK PLUGS (4 OR 6)
CONTROL IGNITION MODULE (EX. TURBO)
HOT AT ALL TIMES
FUEL PUMP RELAY FUSE 16A
COOLING FAN RELAY
GRY
GRY (6 CYL.)
ORG
THERMO SWITCH
DIESEL GLOW PLUG RELAY
CARBURETOR SOLENOID
ORG (EX. FUEL INJ.)
MICRO SWITCH
ENGINE RELAY
COOLING FAN MOTOR
GLOW PLUG
STOP SOLENOID (DIESEL)
FREQUENCY SOLENOID
TO FUEL INJECTION
GRN/YEL
DIESEL CONTROL UNIT
CONSTANT IDLE SPEED MODULE
ENGINE CONTROL MODULE (EX. FUEL INJ.)
ENGINE CONTROL MODULE (WITH FUEL INJ.)
TO TEMPERATURE GAUGE
GRN/BLU
PNK
TO TEST CONNECTOR
TEMPERATURE SENSOR
DIFFERENTIAL PRESSURE (B 28 F)
IGNITION SWITCH
TEMPERATURE SWITCH
AIR METER
TEMPERATURE SENDER
SWITCH (A/T)
AIR CONTROL SOLENOID
OXYGEN SENSOR
THERMO SWITCH
PRESSURE SWITCH (TURBO)
OXYGEN SENSOR
87866419

Fig. 104 Engine and chassis wiring — 1982 200 and 700 series

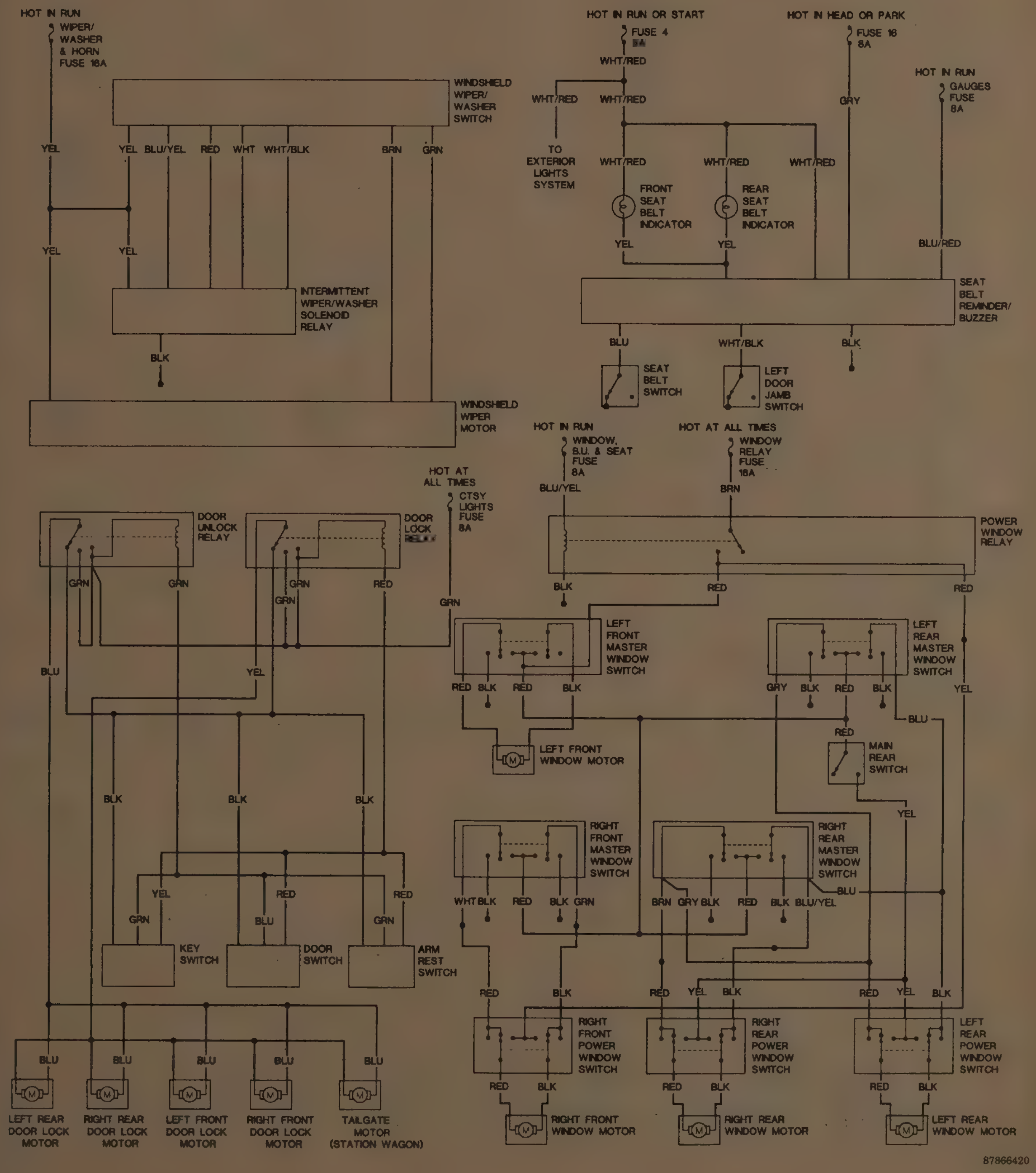
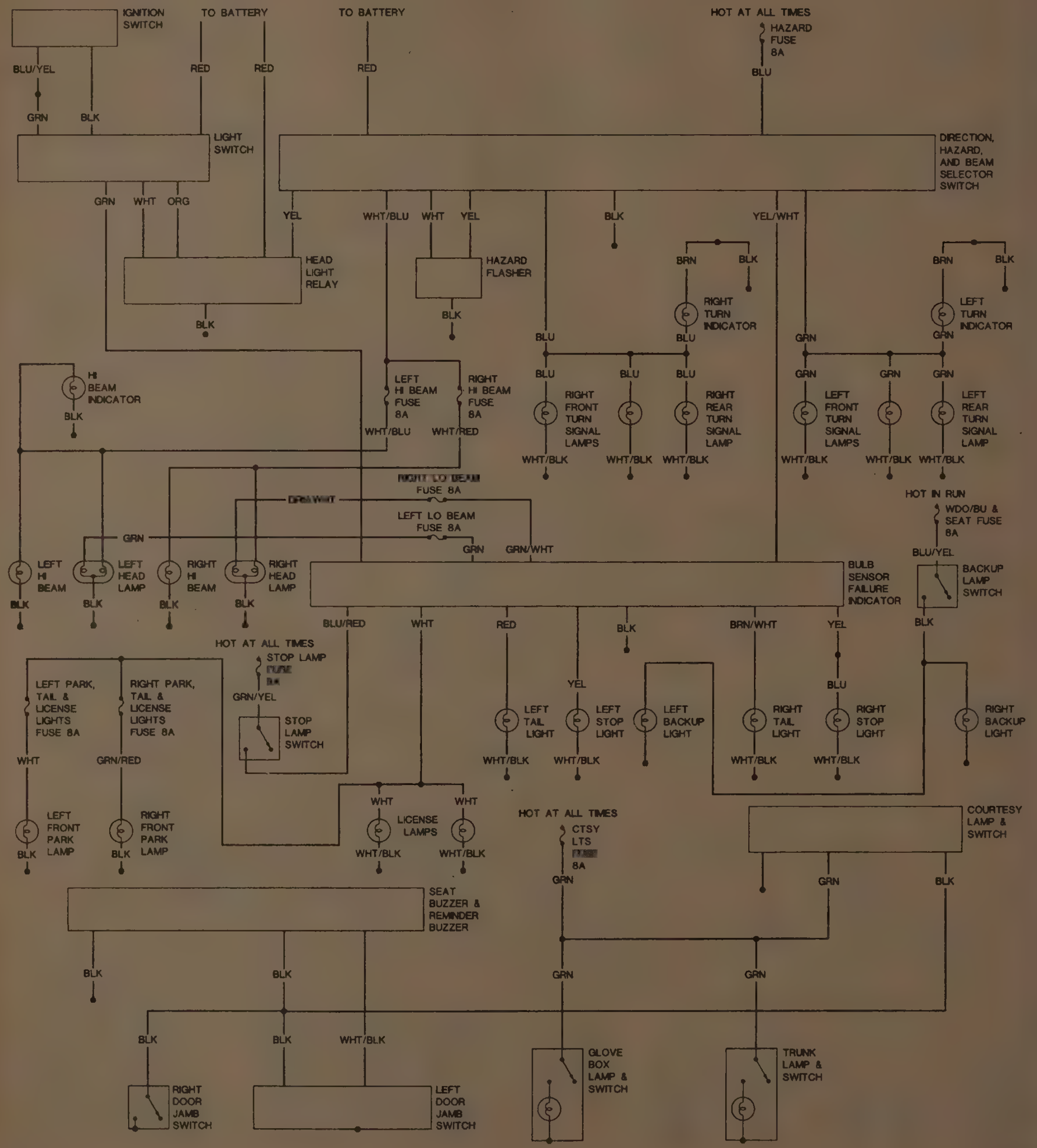

HOT IN RUN
WIPER/ WASHER & HORN FUSE 16A
WINDSHIELD WIPER/ WASHER SWITCH
YEL
YEL
BLU/YEL
RED
WHT
WHT/BLK
BRN
GRN
YEL
YEL
INTERMITTENT WIPER/WASHER SOLENOID RELAY
BLK
WINDSHIELD WIPER MOTOR
HOT IN RUN OR START
FUSE 4 8A
WHT/RED
WHT/RED
WHT/RED
TO EXTERIOR LIGHTS SYSTEM
WHT/RED
WHT/RED
WHT/RED
FRONT SEAT BELT INDICATOR
REAR SEAT BELT INDICATOR
YEL
YEL
HOT IN HEAD OR PARK
FUSE 16 8A
GRY
HOT IN RUN
GAUGES FUSE 8A
BLU/RED
SEAT BELT REMINDER/ BUZZER
BLU
WHT/BLK
BLK
SEAT BELT SWITCH
LEFT DOOR JAMB SWITCH
HOT IN RUN
WINDOW, B.U. & SEAT FUSE 8A
BLU/YEL
HOT AT ALL TIMES
WINDOW RELAY FUSE 16A
BRN
POWER WINDOW RELAY
BLK
RED
RED
HOT AT ALL TIMES
CTSY LIGHTS FUSE 8A
GRN
DOOR UNLOCK RELAY
DOOR LOCK RELAY
GRN
GRN
GRN
GRN
RED
BLU
YEL
LEFT FRONT MASTER WINDOW SWITCH
RED
BLK
RED
BLK
LEFT FRONT WINDOW MOTOR
LEFT REAR MASTER WINDOW SWITCH
GRY
BLK
RED
BLK
YEL
BLU
RED
MAIN REAR SWITCH
YEL
BLK
BLK
BLK
RIGHT FRONT MASTER WINDOW SWITCH
WHT BLK
RED
BLK
GRN
RIGHT REAR MASTER WINDOW SWITCH
BLU
BRN
GRY
BLK
RED
BLK
BLU/YEL
YEL
RED
GRN
BLU
GRN
RED
KEY SWITCH
DOOR SWITCH
ARM REST SWITCH
RED
BLK
RIGHT FRONT POWER WINDOW SWITCH
RED
BLK
RIGHT FRONT WINDOW MOTOR
RED
YEL
BLK
RIGHT REAR POWER WINDOW SWITCH
RED
BLK
RIGHT REAR WINDOW MOTOR
RED
YEL
BLK
LEFT REAR POWER WINDOW SWITCH
RED
BLK
LEFT REAR WINDOW MOTOR
BLU
BLU
BLU
BLU
BLU
LEFT REAR DOOR LOCK MOTOR
RIGHT REAR DOOR LOCK MOTOR
LEFT FRONT DOOR LOCK MOTOR
RIGHT FRONT DOOR LOCK MOTOR
TAILGATE MOTOR (STATION WAGON)
87866420

Fig. 105 Chassis wiring — 1981-82 (all models); 1983-85 DL, GL, Turbo and DL diesel models


IGNITION SWITCH
TO BATTERY
TO BATTERY
HOT AT ALL TIMES
HAZARD FUSE 8A
BLU/YEL
RED
RED
RED
BLU
GRN
BLK
LIGHT SWITCH
DIRECTION, HAZARD, AND BEAM SELECTOR SWITCH
GRN
WHT
ORG
YEL
WHT/BLU
WHT
YEL
BLK
YEL/WHT
HEAD LIGHT RELAY
HAZARD FLASHER
BRN
BLK
BRN
BLK
BLK
BLK
RIGHT TURN INDICATOR
LEFT TURN INDICATOR
BLU
BLU
GRN
GRN
HI BEAM INDICATOR
BLK
LEFT HI BEAM FUSE 8A
RIGHT HI BEAM FUSE 8A
WHT/BLU
WHT/RED
BLU
BLU
BLU
GRN
GRN
GRN
RIGHT FRONT TURN SIGNAL LAMPS
RIGHT REAR TURN SIGNAL LAMP
LEFT FRONT TURN SIGNAL LAMPS
LEFT REAR TURN SIGNAL LAMP
WHT/BLK
WHT/BLK
WHT/BLK
WHT/BLK
WHT/BLK
WHT/BLK
RIGHT LO BEAM FUSE 8A
GRN/WHT
LEFT LO BEAM FUSE 8A
HOT IN RUN
WDO/BU & SEAT FUSE 8A
BLU/YEL
GRN
GRN
GRN/WHT
LEFT HI BEAM
LEFT HEAD LAMP
RIGHT HI BEAM
RIGHT HEAD LAMP
BULB SENSOR FAILURE INDICATOR
BACKUP LAMP SWITCH
BLK
BLK
BLK
BLK
BLU/RED
WHT
RED
BLK
BRN/WHT
YEL
BLK
HOT AT ALL TIMES
STOP LAMP FUSE 8A
GRN/YEL
LEFT PARK, TAIL & LICENSE LIGHTS FUSE 8A
RIGHT PARK, TAIL & LICENSE LIGHTS FUSE 8A
STOP LAMP SWITCH
YEL
BLU
LEFT TAIL LIGHT
LEFT STOP LIGHT
LEFT BACKUP LIGHT
RIGHT TAIL LIGHT
RIGHT STOP LIGHT
RIGHT BACKUP LIGHT
WHT
GRN/RED
WHT/BLK
WHT/BLK
WHT/BLK
WHT/BLK
WHT
WHT
LICENSE LAMPS
HOT AT ALL TIMES
CTSY LTS FUSE 8A
COURTESY LAMP & SWITCH
LEFT FRONT PARK LAMP
RIGHT FRONT PARK LAMP
BLK
BLK
WHT/BLK
WHT/BLK
GRN
GRN
BLK
SEAT BUZZER & REMINDER BUZZER
BLK
BLK
GRN
GRN
BLK
BLK
WHT/BLK
GLOVE BOX LAMP & SWITCH
TRUNK LAMP & SWITCH
RIGHT DOOR JAMB SWITCH
LEFT DOOR JAMB SWITCH

87866421

Fig. 106 Chassis wiring — 1983-84 760 GLE and GLE turbo diesel models

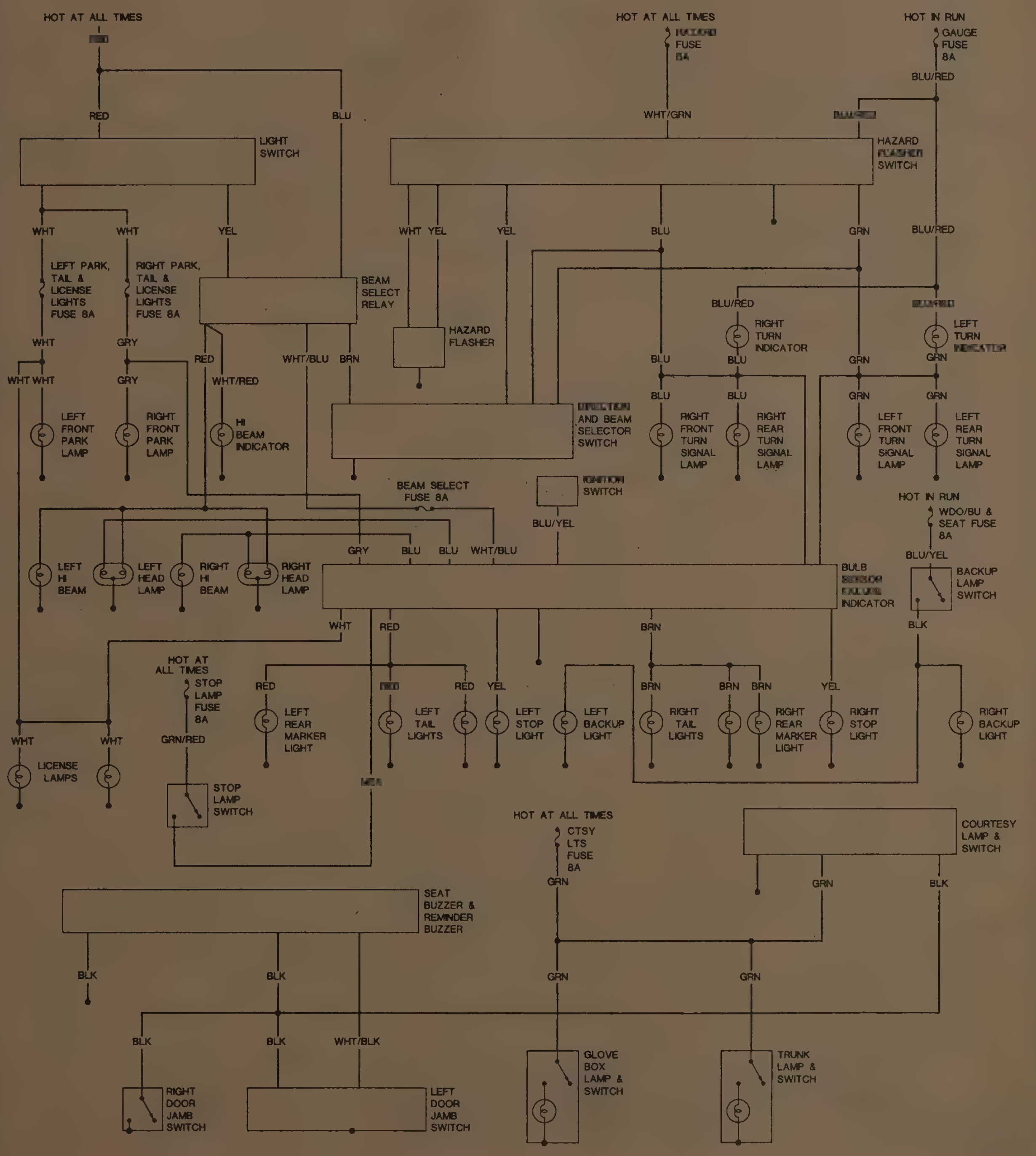

HOT AT ALL TIMES
RED
BLU
LIGHT SWITCH
HOT AT ALL TIMES
HAZARD FUSE 8A
WHT/GRN
HOT IN RUN
GAUGE FUSE 8A
BLU/RED
BLU/RED
HAZARD FLASHER SWITCH
WHT
WHT
YEL
WHT
YEL
YEL
BLU
GRN
BLU/RED
LEFT PARK, TAIL & LICENSE LIGHTS FUSE 8A
RIGHT PARK, TAIL & LICENSE LIGHTS FUSE 8A
BEAM SELECT RELAY
HAZARD FLASHER
BLU/RED
RIGHT TURN INDICATOR
BLU/RED
LEFT TURN INDICATOR
WHT
GRY
RED
WHT/BLU
BRN
BLU
BLU
GRN
GRN
WHT WHT
GRY
WHT/RED
BLU
BLU
GRN
GRN
LEFT FRONT PARK LAMP
RIGHT FRONT PARK LAMP
HI BEAM INDICATOR
DIRECTION AND BEAM SELECTOR SWITCH
RIGHT FRONT TURN SIGNAL LAMP
RIGHT REAR TURN SIGNAL LAMP
LEFT FRONT TURN SIGNAL LAMP
LEFT REAR TURN SIGNAL LAMP
BEAM SELECT FUSE 8A
IGNITION SWITCH
BLU/YEL
HOT IN RUN
WDO/BU & SEAT FUSE 8A
BLU/YEL
LEFT HI BEAM
LEFT HEAD LAMP
RIGHT HI BEAM
RIGHT HEAD LAMP
GRY
BLU
BLU
WHT/BLU
BULB SENSOR FAILURE INDICATOR
BACKUP LAMP SWITCH
BLK
WHT
RED
BRN
HOT AT ALL TIMES
STOP LAMP FUSE 8A
RED
RED
RED
YEL
BRN
BRN
BRN
YEL
LEFT REAR MARKER LIGHT
LEFT TAIL LIGHTS
LEFT STOP LIGHT
LEFT BACKUP LIGHT
RIGHT TAIL LIGHTS
RIGHT REAR MARKER LIGHT
RIGHT STOP LIGHT
RIGHT BACKUP LIGHT
WHT
WHT
GRN/RED
LICENSE LAMPS
STOP LAMP SWITCH
HOT AT ALL TIMES
CTSY LTS FUSE 8A
GRN
COURTESY LAMP & SWITCH
GRN
BLK
SEAT BUZZER & REMINDER BUZZER
BLK
BLK
GRN
GRN
BLK
BLK
WHT/BLK
GLOVE BOX LAMP & SWITCH
TRUNK LAMP & SWITCH
RIGHT DOOR JAMB SWITCH
LEFT DOOR JAMB SWITCH

Fig. 107 Chassis wiring — 1981-82 (all models); 1983-85 GL, DL and DL diesel models

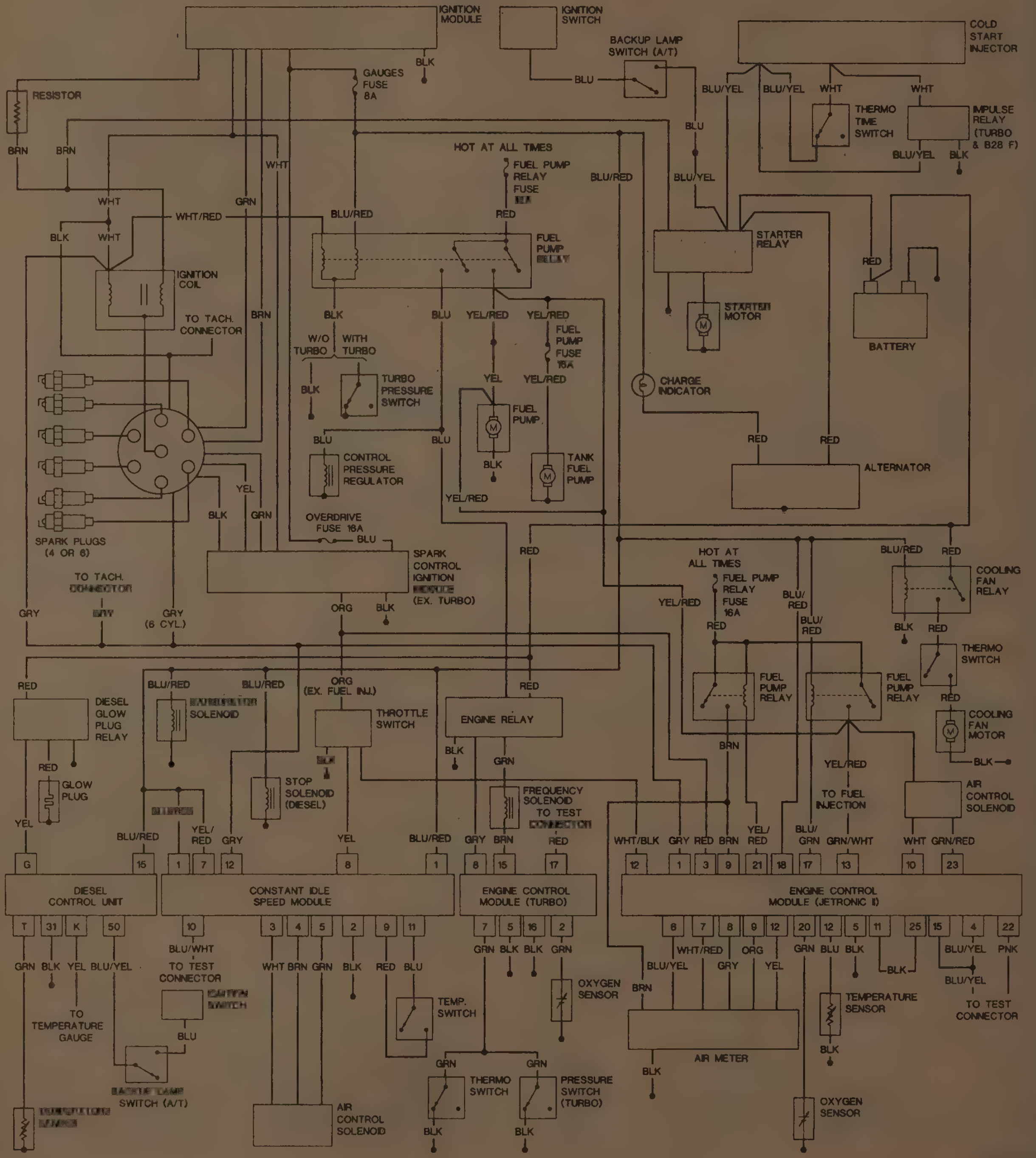

IGNITION MODULE
IGNITION SWITCH
BACKUP LAMP SWITCH (A/T)
COLD START INJECTOR
RESISTOR
BRN
BRN
GAUGES FUSE 8A
BLK
BLU
BLU/YEL
BLU/YEL
WHT
WHT
THERMO TIME SWITCH
IMPULSE RELAY (TURBO & B28 F)
BLU/YEL
BLK
BLU
HOT AT ALL TIMES
FUEL PUMP RELAY FUSE
WHT
BLU/RED
BLU/YEL
WHT
GRN
WHT/RED
BLU/RED
RED
FUEL PUMP RELAY
STARTER RELAY
BLK
WHT
IGNITION COIL
RED
TO TACH. CONNECTOR
BRN
BLK
BLU
YEL/RED
YEL/RED
STARTER MOTOR
BATTERY
W/O TURBO
WITH TURBO
FUEL PUMP FUSE 16A
BLK
TURBO PRESSURE SWITCH
YEL
YEL/RED
CHARGE INDICATOR
FUEL PUMP
BLU
BLU
CONTROL PRESSURE REGULATOR
BLK
TANK FUEL PUMP
RED
RED
ALTERNATOR
YEL
YEL/RED
BLK
GRN
OVERDRIVE FUSE 16A
BLU
SPARK PLUGS (4 OR 6)
SPARK CONTROL IGNITION (EX. TURBO)
RED
HOT AT ALL TIMES
FUEL PUMP RELAY FUSE 16A
BLU/RED
RED
COOLING FAN RELAY
TO TACH.
GRY
GRY
GRY (6 CYL.)
ORG
BLK
YEL/RED
BLU/RED
RED
BLU/RED
BLK
RED
THERMO SWITCH
RED
DIESEL GLOW PLUG RELAY
BLU/RED
BLU/RED
SOLENOID
ORG (EX. FUEL INJ.)
THROTTLE SWITCH
RED
ENGINE RELAY
FUEL PUMP RELAY
FUEL PUMP RELAY
RED
COOLING FAN MOTOR
BRN
BLK
RED
GLOW PLUG
STOP SOLENOID (DIESEL)
BLK
GRN
FREQUENCY SOLENOID
TO TEST
YEL/RED
TO FUEL INJECTION
BLK
AIR CONTROL SOLENOID
YEL
BLU/RED
YEL/ RED
GRY
YEL
BLU/RED
GRY
BRN
RED
WHT/BLK
GRY
RED
BRN
YEL/ RED
BLU/ GRN
GRN/WHT
WHT
GRN/RED
G
15
1
7
12
8
1
8
15
17
12
1
3
9
21
18
17
13
10
23
DIESEL CONTROL UNIT
CONSTANT IDLE SPEED MODULE
ENGINE CONTROL MODULE (TURBO)
ENGINE CONTROL MODULE (JETRONIC II)
T
31
K
50
10
3
4
5
2
9
11
7
5
16
2
6
7
8
9
12
20
12
5
11
25
15
4
22
GRN
BLK
YEL
BLU/YEL
BLU/WHT
TO TEST CONNECTOR
WHT
BRN
GRN
BLK
RED
BLU
GRN
BLK
BLK
GRN
WHT/RED
ORG
GRN
BLU
BLK
BLU/YEL
PNK
BLU/YEL
GRY
YEL
BLK
BLU/YEL
TO TEMPERATURE GAUGE
OXYGEN SENSOR
BRN
TEMPERATURE SENSOR
TO TEST CONNECTOR
TEMP. SWITCH
BLU
AIR METER
BLK
GRN
GRN
THERMO SWITCH
PRESSURE SWITCH (TURBO)
BLK
SWITCH (A/T)
AIR CONTROL SOLENOID
BLK
BLK
OXYGEN SENSOR
87866423

Fig. 108 Chassis wiring — 1983-84 GL, DL, Turbo and DL diesel models

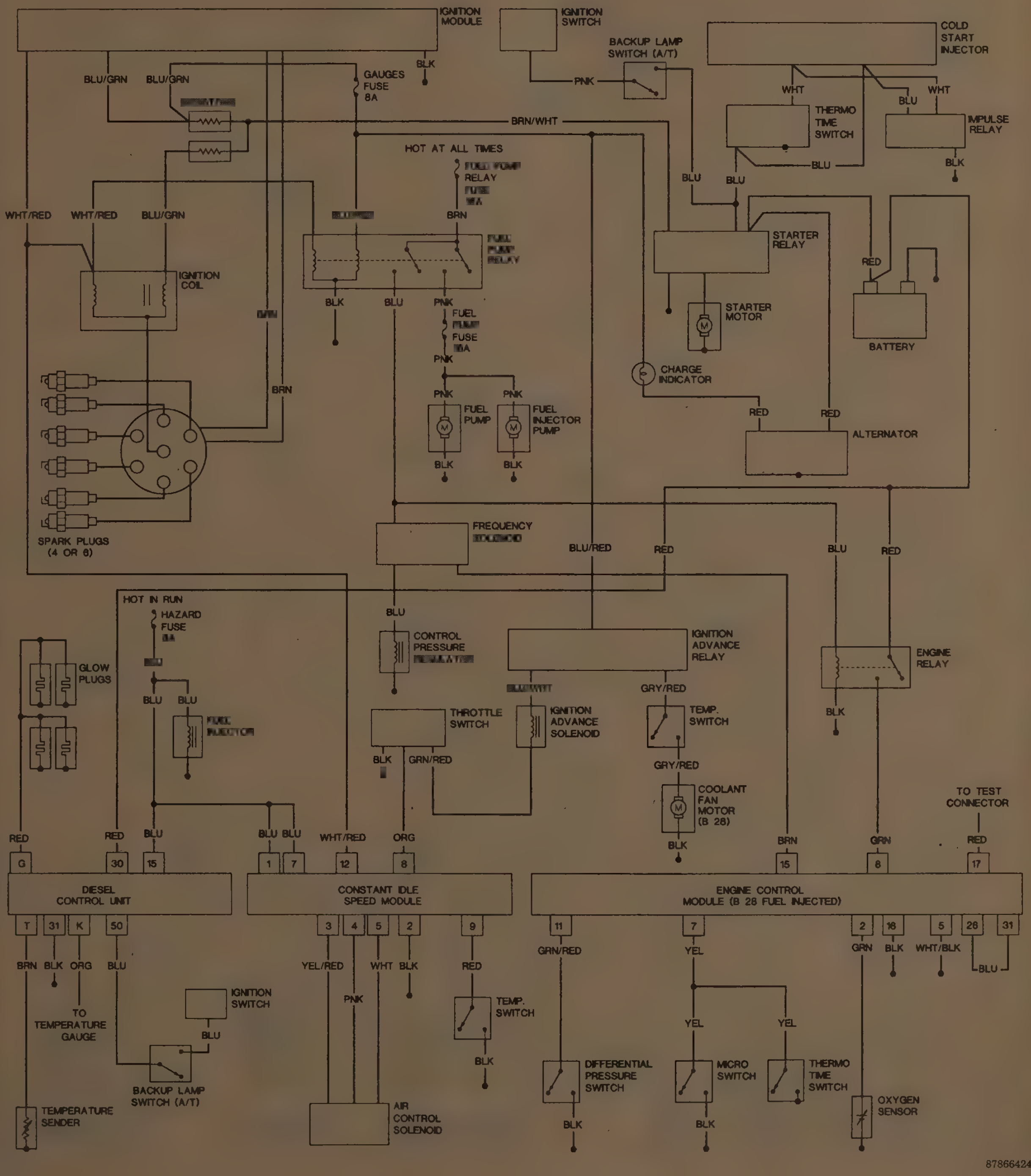

IGNITION MODULE
IGNITION SWITCH
BACKUP LAMP SWITCH (A/T)
COLD START INJECTOR
BLK
PNK
BLU/GRN
BLU/GRN
GAUGES FUSE 8A
BRN/WHT
WHT
WHT
BLU
THERMO TIME SWITCH
IMPULSE RELAY
BLU
BLK
HOT AT ALL TIMES
RELAY
BLU
BLU
WHT/RED
WHT/RED
BLU/GRN
BRN
STARTER RELAY
RED
IGNITION COIL
BLK
BLU
PNK
FUEL
FUSE
PNK
STARTER MOTOR
BATTERY
CHARGE INDICATOR
BRN
PNK
PNK
FUEL PUMP
FUEL INJECTOR PUMP
BLK
BLK
RED
RED
ALTERNATOR
SPARK PLUGS (4 OR 6)
FREQUENCY
BLU/RED
RED
BLU
RED
HOT IN RUN
HAZARD FUSE
BLU
CONTROL PRESSURE
IGNITION ADVANCE RELAY
ENGINE RELAY
GLOW PLUGS
BLU
BLU
GRY/RED
THROTTLE SWITCH
IGNITION ADVANCE SOLENOID
TEMP. SWITCH
BLK
BLK
GRN/RED
GRY/RED
COOLANT FAN MOTOR (B 28)
TO TEST CONNECTOR
RED
RED
BLU
BLU
BLU
WHT/RED
ORG
BLK
BRN
GRN
RED
G
30
15
1
7
12
8
15
8
17
DIESEL CONTROL UNIT
CONSTANT IDLE SPEED MODULE
ENGINE CONTROL MODULE (B 28 FUEL INJECTED)
T
31
K
50
3
4
5
2
9
11
7
2
16
5
26
31
BRN
BLK
ORG
BLU
YEL/RED
WHT
BLK
RED
GRN/RED
YEL
GRN
BLK
WHT/BLK
BLU
IGNITION SWITCH
TO TEMPERATURE GAUGE
PNK
TEMP. SWITCH
YEL
YEL
BLU
BLK
BACKUP LAMP SWITCH (A/T)
DIFFERENTIAL PRESSURE SWITCH
MICRO SWITCH
THERMO TIME SWITCH
TEMPERATURE SENDER
AIR CONTROL SOLENOID
BLK
BLK
OXYGEN SENSOR
87866424

Fig. 109 Engine and chassis wiring — 1983-84 760 GLE and 760 GLE turbo diesel models

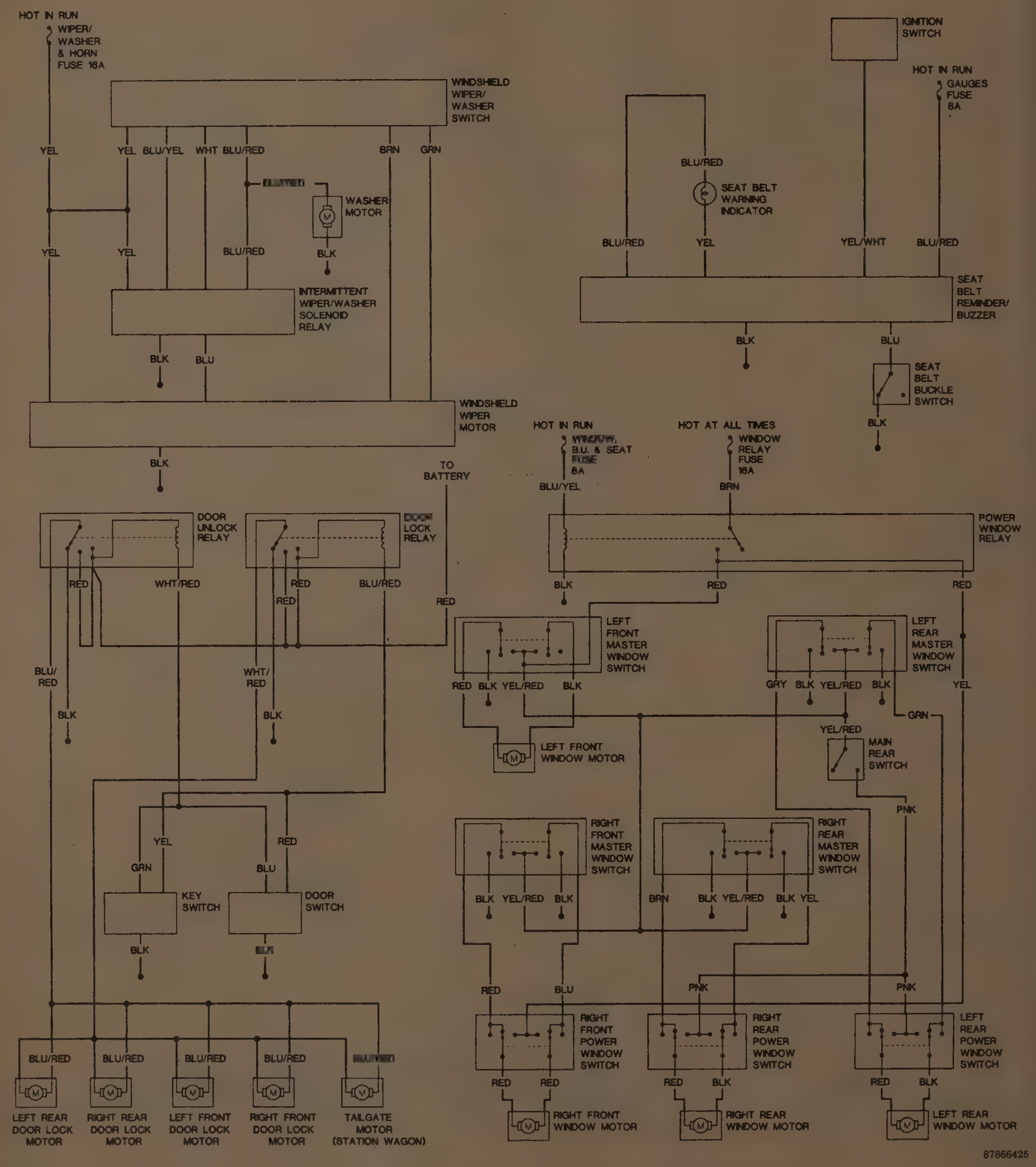

HOT IN RUN
WIPER/ WASHER & HORN FUSE 16A
WINDSHIELD WIPER/ WASHER SWITCH
YEL
YEL
BLU/YEL
WHT
BLU/RED
BRN
GRN
BLU/YEL
WASHER MOTOR
YEL
YEL
BLU/RED
BLK
INTERMITTENT WIPER/WASHER SOLENOID RELAY
BLK
BLU
WINDSHIELD WIPER MOTOR
BLK
TO BATTERY
IGNITION SWITCH
HOT IN RUN
GAUGES FUSE 8A
BLU/RED
SEAT BELT WARNING INDICATOR
BLU/RED
YEL
YEL/WHT
BLU/RED
SEAT BELT REMINDER/ BUZZER
BLK
BLU
SEAT BELT BUCKLE SWITCH
BLK
HOT IN RUN
WINDOW, B.U. & SEAT FUSE 8A
HOT AT ALL TIMES
WINDOW RELAY FUSE 16A
BLU/YEL
BRN
DOOR UNLOCK RELAY
DOOR LOCK RELAY
POWER WINDOW RELAY
RED
WHT/RED
RED
RED
BLU/RED
RED
BLK
RED
RED
BLU/ RED
WHT/ RED
BLK
BLK
LEFT FRONT MASTER WINDOW SWITCH
RED
BLK
YEL/RED
BLK
LEFT FRONT WINDOW MOTOR
LEFT REAR MASTER WINDOW SWITCH
GRY
BLK
YEL/RED
BLK
YEL
GRN
YEL/RED
MAIN REAR SWITCH
PNK
YEL
RED
GRN
BLU
KEY SWITCH
DOOR SWITCH
BLK
BLK
RIGHT FRONT MASTER WINDOW SWITCH
BLK
YEL/RED
BLK
RIGHT REAR MASTER WINDOW SWITCH
BRN
BLK
YEL/RED
BLK
YEL
RED
BLU
PNK
PNK
RIGHT FRONT POWER WINDOW SWITCH
RIGHT REAR POWER WINDOW SWITCH
LEFT REAR POWER WINDOW SWITCH
RED
RED
RED
BLK
RED
BLK
RIGHT FRONT WINDOW MOTOR
RIGHT REAR WINDOW MOTOR
LEFT REAR WINDOW MOTOR
BLU/RED
BLU/RED
BLU/RED
BLU/RED
BLU/RED
LEFT REAR DOOR LOCK MOTOR
RIGHT REAR DOOR LOCK MOTOR
LEFT FRONT DOOR LOCK MOTOR
RIGHT FRONT DOOR LOCK MOTOR
TAILGATE MOTOR (STATION WAGON)
87866425

Fig. 110 Chassis wiring — 1983-84 760 GLE and 760 GLE turbo models

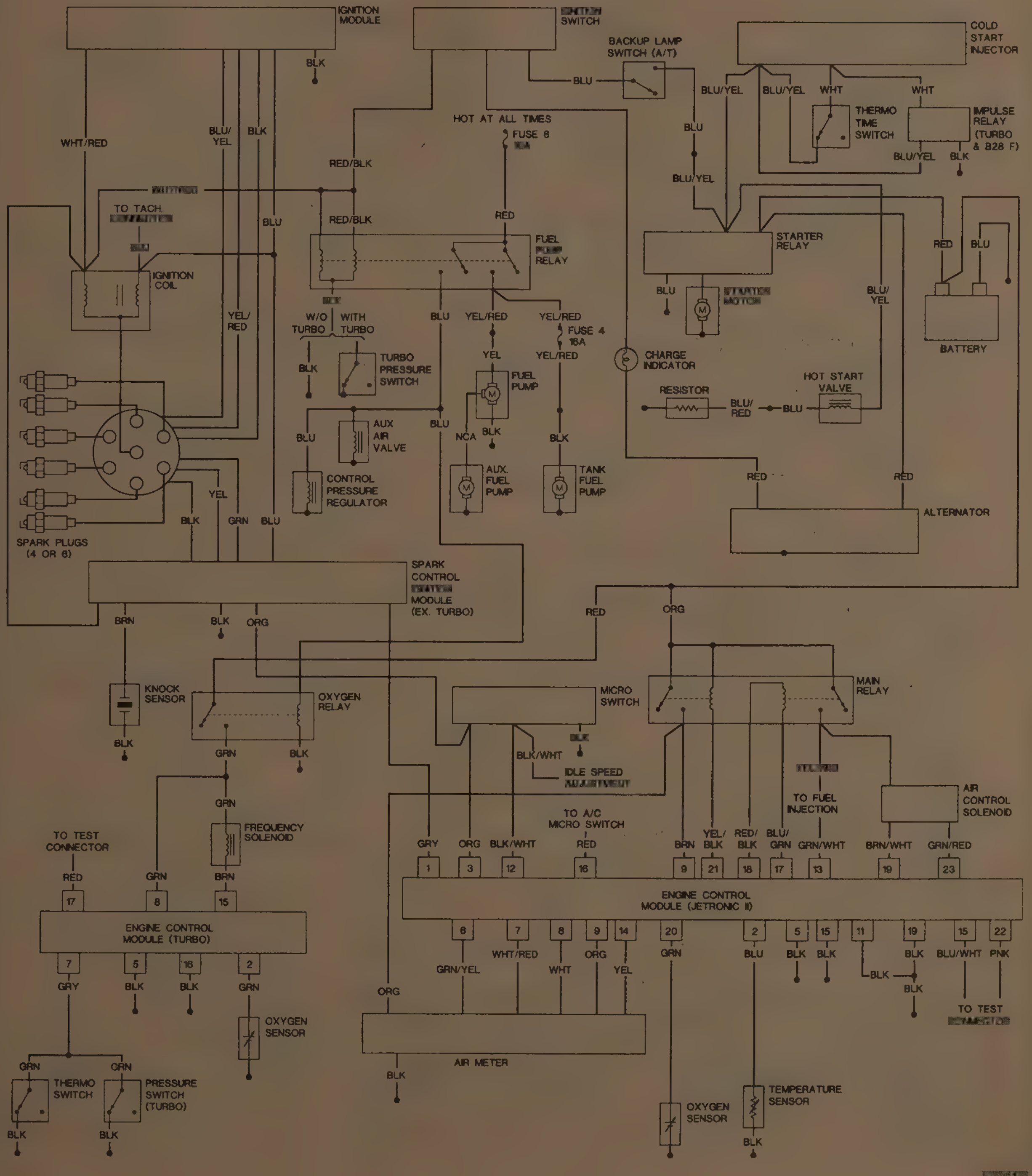

IGNITION MODULE
SWITCH
BLK
BACKUP LAMP SWITCH (A/T)
BLU
COLD START INJECTOR
BLU/YEL
BLU/YEL
WHT
WHT
THERMO TIME SWITCH
IMPULSE RELAY (TURBO & B28 F)
BLU/YEL
BLK
WHT/RED
BLU/ YEL
BLK
HOT AT ALL TIMES
FUSE 8
RED/BLK
BLU
BLU/YEL
TO TACH.
BLU
RED/BLK
RED
FUEL RELAY
STARTER RELAY
RED
BLU
IGNITION COIL
YEL/ RED
W/O TURBO
WITH TURBO
BLU
YEL/RED
YEL/RED
FUSE 4 16A
BLU
BLU/ YEL
BLK
TURBO PRESSURE SWITCH
YEL
FUEL PUMP
YEL/RED
CHARGE INDICATOR
BATTERY
RESISTOR
BLU/ RED
BLU
HOT START VALVE
BLU
AUX AIR VALVE
BLU
NCA
BLK
BLK
CONTROL PRESSURE REGULATOR
AUX. FUEL PUMP
TANK FUEL PUMP
RED
RED
YEL
ALTERNATOR
BLK
GRN
BLU
SPARK PLUGS (4 OR 6)
SPARK CONTROL MODULE (EX. TURBO)
BRN
BLK
ORG
RED
ORG
KNOCK SENSOR
OXYGEN RELAY
MICRO SWITCH
MAIN RELAY
BLK
GRN
BLK
BLK/WHT
IDLE SPEED
GRN
TO FUEL INJECTION
AIR CONTROL SOLENOID
TO TEST CONNECTOR
FREQUENCY SOLENOID
TO A/C MICRO SWITCH
RED
GRN
BRN
GRY
ORG
BLK/WHT
RED
BRN
YEL/ BLK
RED/ BLK
BLU/ GRN
GRN/WHT
BRN/WHT
GRN/RED
17
8
15
1
3
12
16
9
21
18
17
13
19
23
ENGINE CONTROL MODULE (TURBO)
ENGINE CONTROL MODULE (JETRONIC II)
7
5
16
2
6
7
8
9
14
20
2
5
15
11
19
15
22
GRY
BLK
BLK
GRN
GRN/YEL
WHT/RED
WHT
ORG
YEL
GRN
BLU
BLK
BLK
BLK
BLK
BLU/WHT
PNK
OXYGEN SENSOR
ORG
BLK
TO TEST
AIR METER
BLK
GRN
GRN
THERMO SWITCH
PRESSURE SWITCH (TURBO)
BLK
BLK
OXYGEN SENSOR
TEMPERATURE SENSOR
BLK

Fig. 111 Engine and chassis wiring — 1985 GL, DL and Turbo models

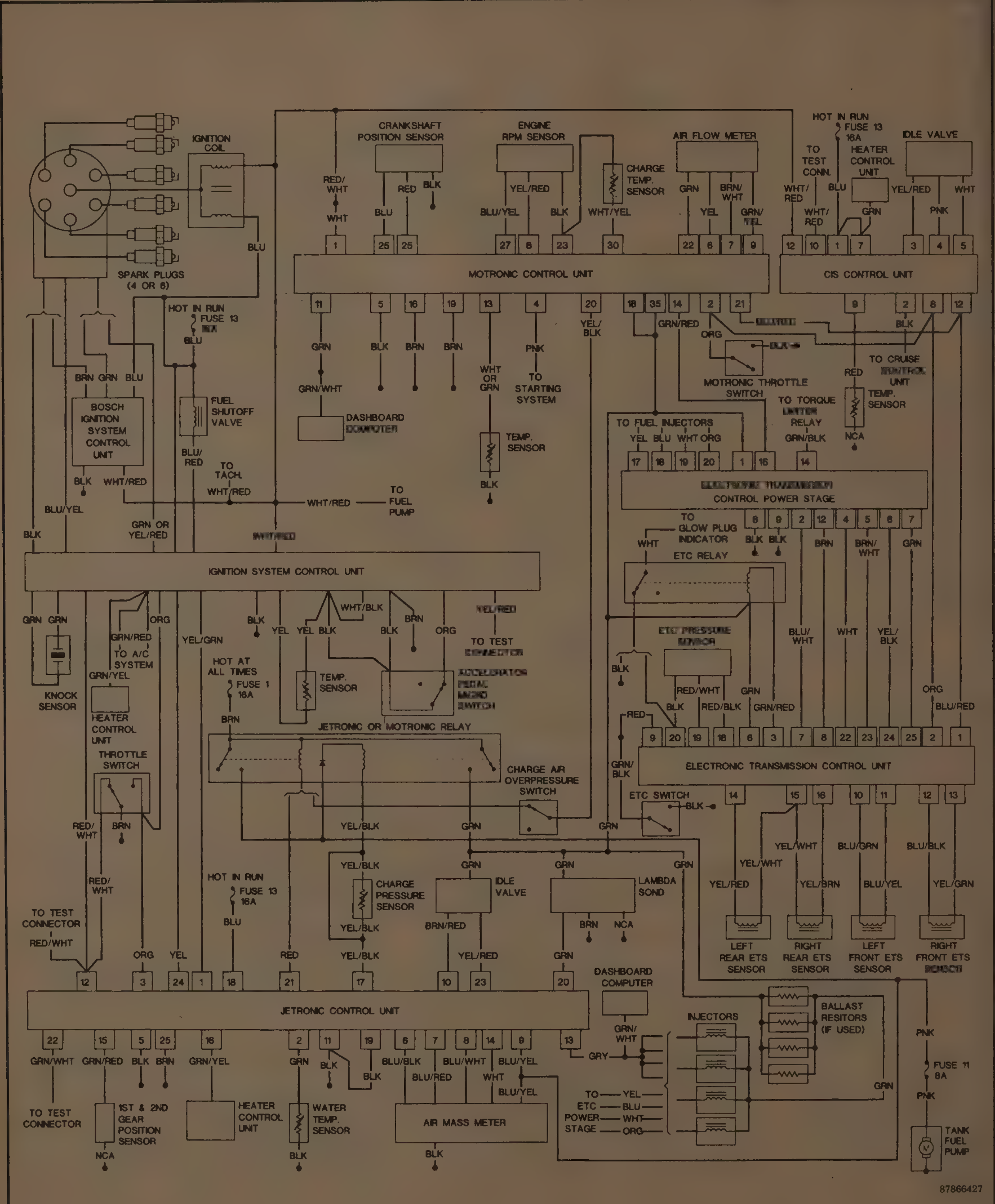

IGNITION COIL
SPARK PLUGS (4 OR 6)
CRANKSHAFT POSITION SENSOR
ENGINE RPM SENSOR
CHARGE TEMP. SENSOR
AIR FLOW METER
HOT IN RUN FUSE 13 16A
TO TEST CONN.
HEATER CONTROL UNIT
IDLE VALVE
MOTRONIC CONTROL UNIT
CIS CONTROL UNIT
HOT IN RUN FUSE 13 16A
BOSCH IGNITION SYSTEM CONTROL UNIT
FUEL SHUTOFF VALVE
TO TACH.
DASHBOARD COMPUTER
TO STARTING SYSTEM
TEMP. SENSOR
TO FUEL PUMP
MOTRONIC THROTTLE SWITCH
TO CRUISE CONTROL UNIT
TO TORQUE LIMITER RELAY
TEMP. SENSOR
TO FUEL INJECTORS
ELECTRONIC TRANSMISSION CONTROL POWER STAGE
TO GLOW PLUG INDICATOR
ETC RELAY
ETC PRESSURE SENSOR
IGNITION SYSTEM CONTROL UNIT
KNOCK SENSOR
TO A/C SYSTEM
HEATER CONTROL UNIT
THROTTLE SWITCH
HOT AT ALL TIMES FUSE 1 16A
TEMP. SENSOR
TO TEST CONNECTOR
ACCELERATOR PEDAL MICRO SWITCH
JETRONIC OR MOTRONIC RELAY
CHARGE AIR OVERPRESSURE SWITCH
ELECTRONIC TRANSMISSION CONTROL UNIT
ETC SWITCH
CHARGE PRESSURE SENSOR
IDLE VALVE
LAMBDA SOND
HOT IN RUN FUSE 13 16A
TO TEST CONNECTOR
LEFT REAR ETS SENSOR
RIGHT REAR ETS SENSOR
LEFT FRONT ETS SENSOR
RIGHT FRONT ETS SENSOR
DASHBOARD COMPUTER
JETRONIC CONTROL UNIT
INJECTORS
BALLAST RESITORS (IF USED)
FUSE 11 8A
TO TEST CONNECTOR
1ST & 2ND GEAR POSITION SENSOR
HEATER CONTROL UNIT
WATER TEMP. SENSOR
AIR MASS METER
TO ETC POWER STAGE
TANK FUEL PUMP
87866427

Fig. 112 Chassis wiring — 1985 740 GLE and Turbo; 760 GLE, GLE Turbo and turbo diesel models

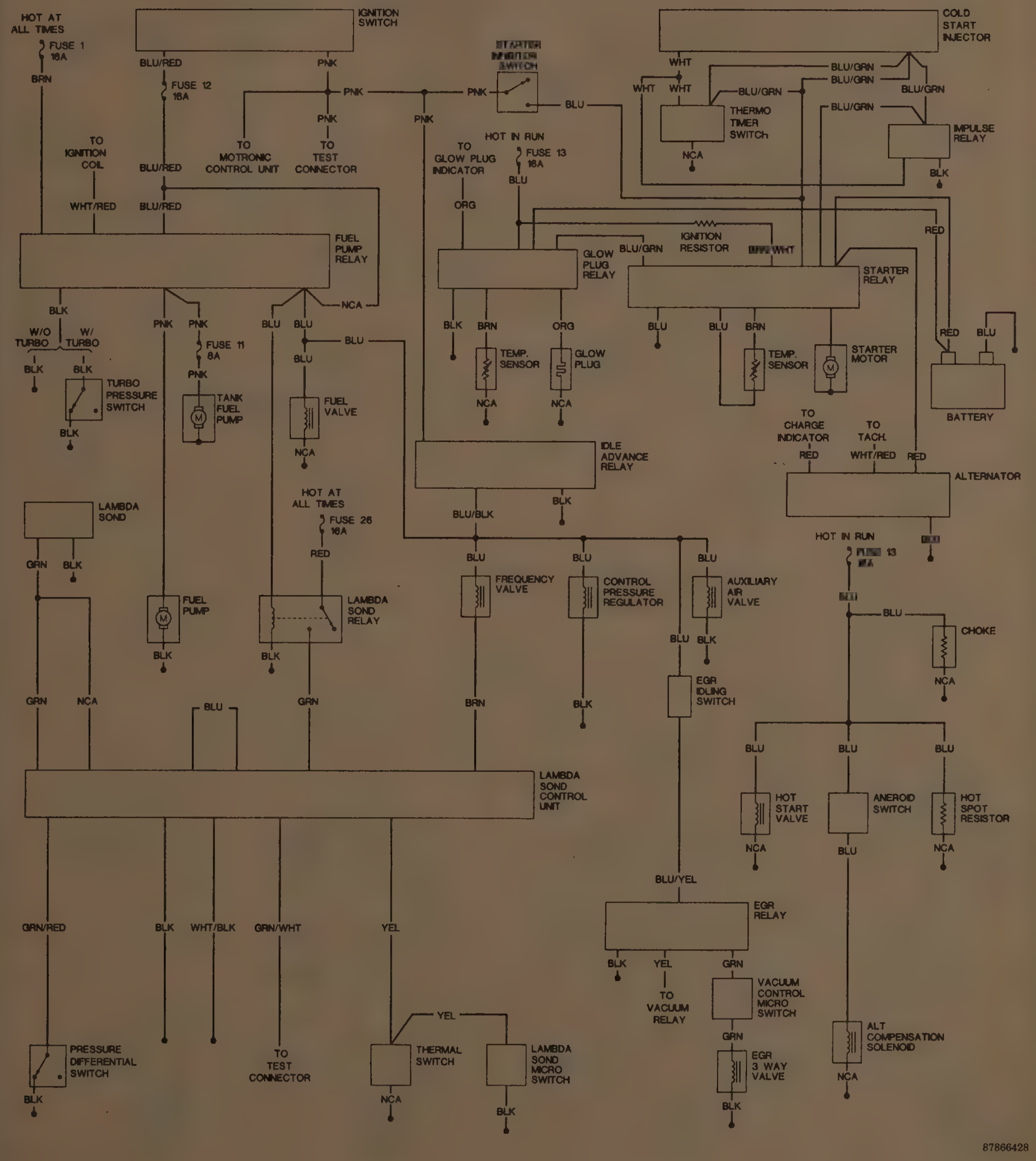

HOT AT ALL TIMES
FUSE 1 16A
BRN
IGNITION SWITCH
BLU/RED
FUSE 12 16A
PNK
STARTER INHIBITOR SWITCH
BLU
TO IGNITION COIL
TO MOTRONIC CONTROL UNIT
TO TEST CONNECTOR
WHT/RED
FUEL PUMP RELAY
NCA
BLK
W/O TURBO
W/ TURBO
TURBO PRESSURE SWITCH
FUSE 11 8A
TANK FUEL PUMP
FUEL VALVE
LAMBDA SOND
GRN
FUEL PUMP
HOT AT ALL TIMES
FUSE 26 16A
RED
LAMBDA SOND RELAY
LAMBDA SOND CONTROL UNIT
GRN/RED
WHT/BLK
GRN/WHT
YEL
PRESSURE DIFFERENTIAL SWITCH
TO TEST CONNECTOR
THERMAL SWITCH
LAMBDA SOND MICRO SWITCH
HOT IN RUN
TO GLOW PLUG INDICATOR
FUSE 13 16A
ORG
GLOW PLUG RELAY
TEMP. SENSOR
GLOW PLUG
IDLE ADVANCE RELAY
BLU/BLK
FREQUENCY VALVE
CONTROL PRESSURE REGULATOR
AUXILIARY AIR VALVE
EGR IDLING SWITCH
BLU/YEL
EGR RELAY
TO VACUUM RELAY
VACUUM CONTROL MICRO SWITCH
EGR 3 WAY VALVE
COLD START INJECTOR
WHT
BLU/GRN
THERMO TIMER SWITCH
IMPULSE RELAY
IGNITION RESISTOR
STARTER RELAY
STARTER MOTOR
BATTERY
TO CHARGE INDICATOR
TO TACH.
ALTERNATOR
FUSE 13
CHOKE
HOT START VALVE
ANEROID SWITCH
HOT SPOT RESISTOR
ALT COMPENSATION SOLENOID
87866428

Fig. 113 Engine and chassis wiring — 1985 740 GLE and Turbo; 760 GLE, GLE Turbo and turbo diesel models

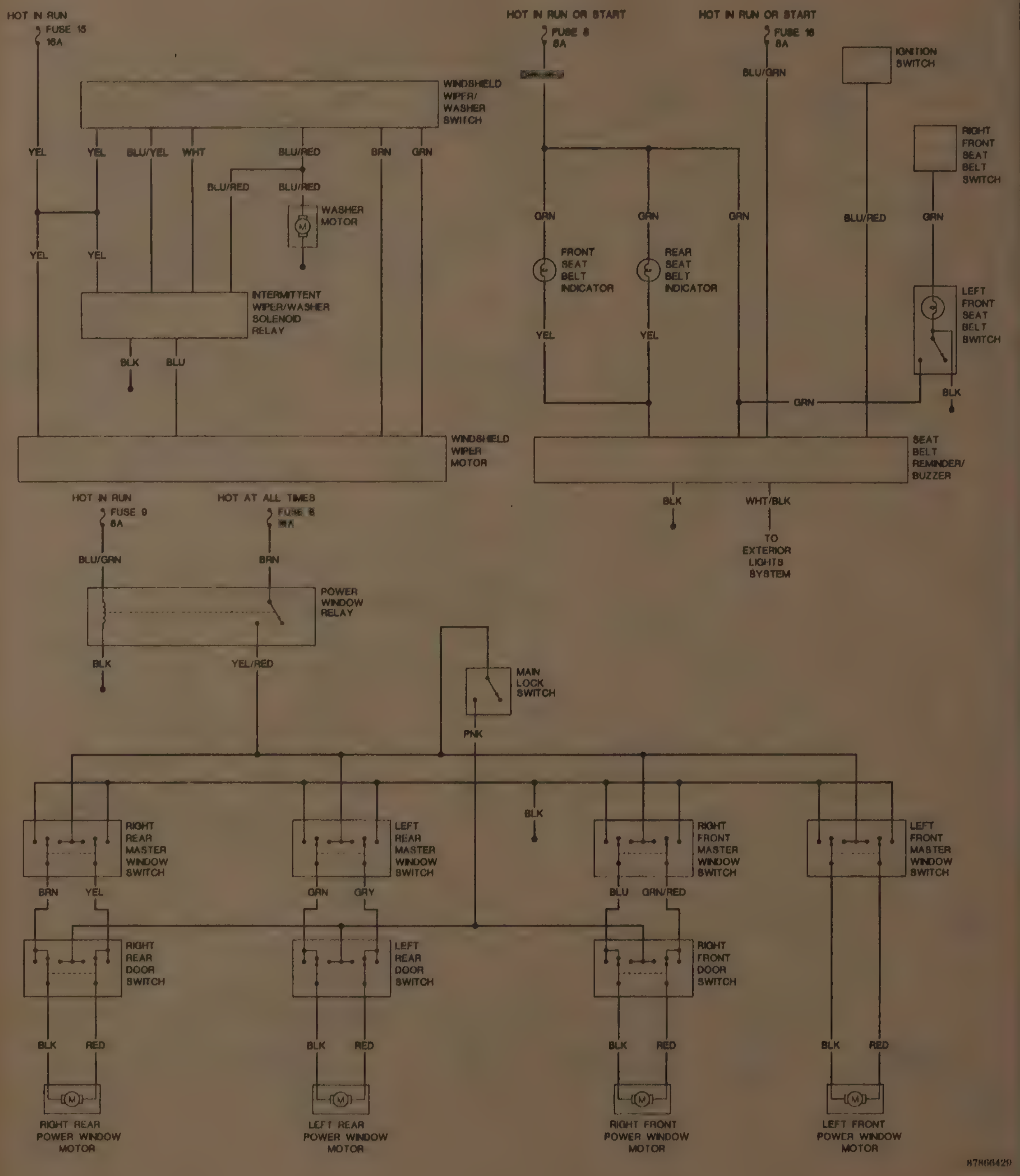

HOT IN RUN
FUSE 15
16A
WINDSHIELD WIPER/ WASHER SWITCH
YEL
YEL
BLU/YEL
WHT
BLU/RED
BRN
GRN
BLU/RED
BLU/RED
WASHER MOTOR
M
YEL
YEL
INTERMITTENT WIPER/WASHER SOLENOID RELAY
BLK
BLU
WINDSHIELD WIPER MOTOR
HOT IN RUN OR START
FUSE 8
8A
HOT IN RUN OR START
FUSE 16
8A
BLU/GRN
IGNITION SWITCH
RIGHT FRONT SEAT BELT SWITCH
GRN
GRN
GRN
BLU/RED
GRN
FRONT SEAT BELT INDICATOR
REAR SEAT BELT INDICATOR
LEFT FRONT SEAT BELT SWITCH
YEL
YEL
BLK
GRN
SEAT BELT REMINDER/ BUZZER
BLK
WHT/BLK
TO EXTERIOR LIGHTS SYSTEM
HOT IN RUN
FUSE 9
8A
HOT AT ALL TIMES
FUSE 5
16A
BLU/GRN
BRN
POWER WINDOW RELAY
BLK
YEL/RED
MAIN LOCK SWITCH
PNK
BLK
RIGHT REAR MASTER WINDOW SWITCH
LEFT REAR MASTER WINDOW SWITCH
RIGHT FRONT MASTER WINDOW SWITCH
LEFT FRONT MASTER WINDOW SWITCH
BRN
YEL
GRN
GRY
BLU
GRN/RED
RIGHT REAR DOOR SWITCH
LEFT REAR DOOR SWITCH
RIGHT FRONT DOOR SWITCH
BLK
RED
BLK
RED
BLK
RED
BLK
RED
M
M
M
M
RIGHT REAR POWER WINDOW MOTOR
LEFT REAR POWER WINDOW MOTOR
RIGHT FRONT POWER WINDOW MOTOR
LEFT FRONT POWER WINDOW MOTOR
87866429

Fig. 114 Chassis wiring — 1985 740 GLE and Turbo; 760 GLE, GLE Turbo and turbo diesel models (continued)

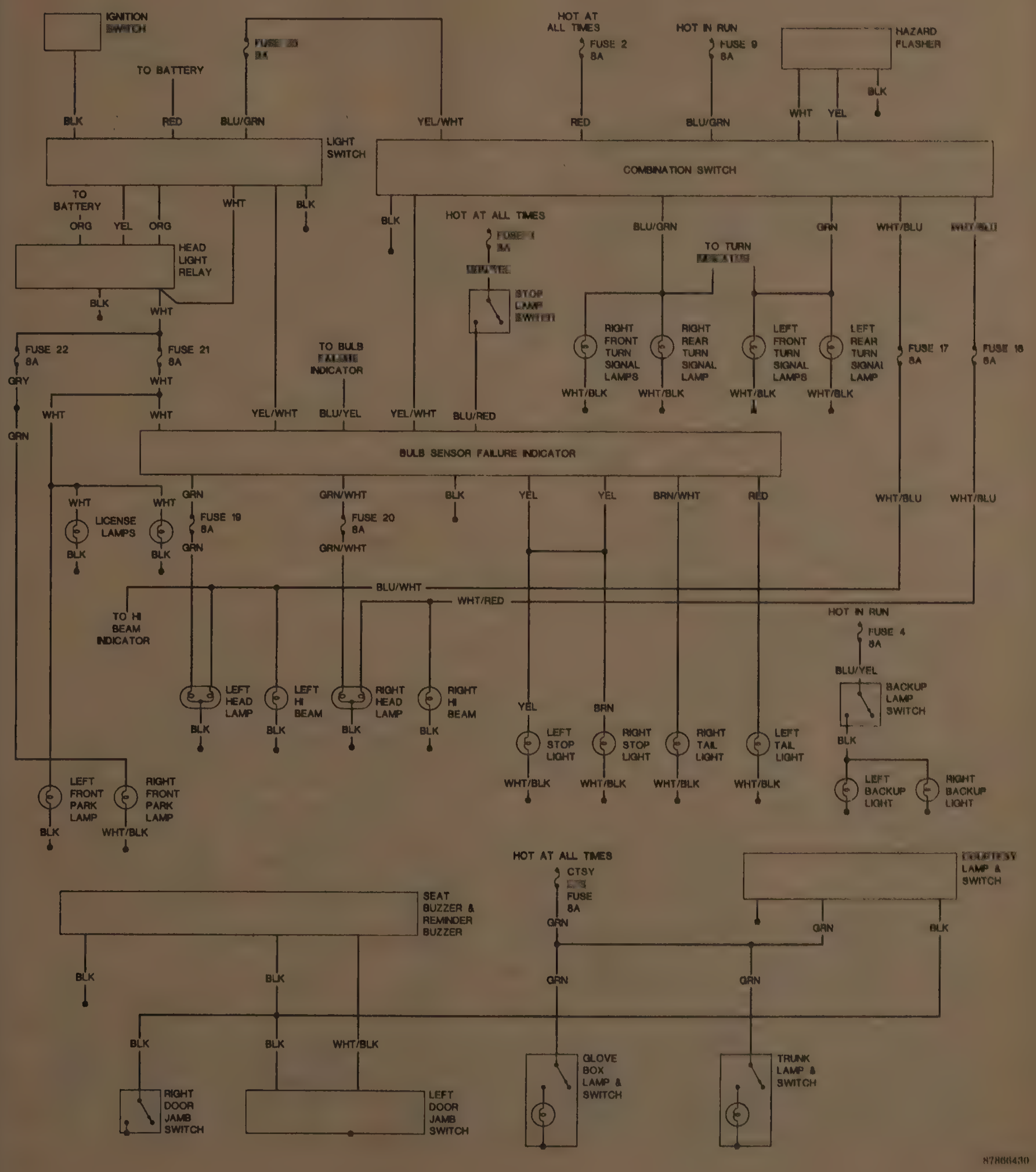

IGNITION SWITCH
TO BATTERY
FUSE 23 8A
HOT AT ALL TIMES
FUSE 2 8A
HOT IN RUN
FUSE 9 8A
HAZARD FLASHER
BLK
WHT
YEL
BLK
RED
BLU/GRN
YEL/WHT
RED
BLU/GRN
LIGHT SWITCH
COMBINATION SWITCH
TO BATTERY
ORG
YEL
ORG
WHT
BLK
BLK
HOT AT ALL TIMES
FUSE 1 8A
GRN/YEL
STOP LAMP SWITCH
BLU/GRN
TO TURN INDICATORS
GRN
WHT/BLU
WHT/BLU
HEAD LIGHT RELAY
BLK
WHT
FUSE 22 8A
FUSE 21 8A
GRY
WHT
TO BULB FAILURE INDICATOR
RIGHT FRONT TURN SIGNAL LAMPS
RIGHT REAR TURN SIGNAL LAMP
LEFT FRONT TURN SIGNAL LAMPS
LEFT REAR TURN SIGNAL LAMP
FUSE 17 8A
FUSE 18 8A
WHT/BLK
WHT/BLK
WHT/BLK
WHT/BLK
GRN
WHT
WHT
YEL/WHT
BLU/YEL
YEL/WHT
BLU/RED
BULB SENSOR FAILURE INDICATOR
WHT
WHT
GRN
FUSE 19 8A
GRN
GRN/WHT
FUSE 20 8A
GRN/WHT
BLK
YEL
YEL
BRN/WHT
RED
WHT/BLU
WHT/BLU
LICENSE LAMPS
BLK
BLK
BLU/WHT
WHT/RED
TO HI BEAM INDICATOR
HOT IN RUN
FUSE 4 8A
BLU/YEL
BACKUP LAMP SWITCH
LEFT HEAD LAMP
LEFT HI BEAM
RIGHT HEAD LAMP
RIGHT HI BEAM
YEL
BRN
BLK
BLK
BLK
BLK
LEFT STOP LIGHT
RIGHT STOP LIGHT
RIGHT TAIL LIGHT
LEFT TAIL LIGHT
BLK
LEFT BACKUP LIGHT
RIGHT BACKUP LIGHT
WHT/BLK
WHT/BLK
WHT/BLK
WHT/BLK
LEFT FRONT PARK LAMP
RIGHT FRONT PARK LAMP
BLK
WHT/BLK
HOT AT ALL TIMES
CTSY LTS FUSE 8A
GRN
COURTESY LAMP & SWITCH
SEAT BUZZER & REMINDER BUZZER
GRN
BLK
BLK
BLK
GRN
GRN
BLK
BLK
WHT/BLK
GLOVE BOX LAMP & SWITCH
TRUNK LAMP & SWITCH
RIGHT DOOR JAMB SWITCH
LEFT DOOR JAMB SWITCH
87866430

Fig. 115 Chassis wiring — 1985 740 GLE and Turbo; 760 GLE, GLE Turbo and turbo diesel models (continued)

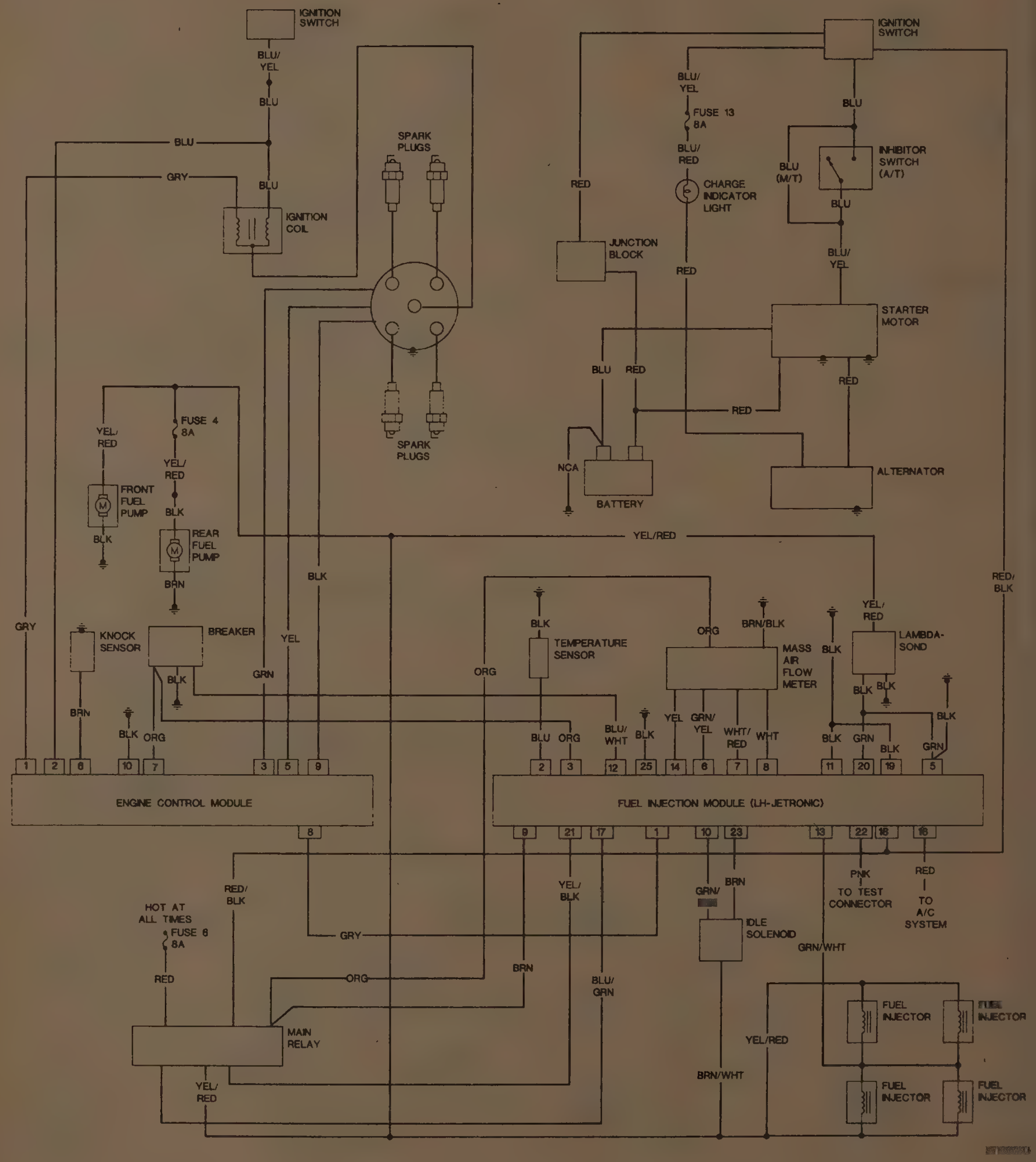

IGNITION SWITCH
BLU/ YEL
BLU
BLU
GRY
BLU
IGNITION COIL
SPARK PLUGS
SPARK PLUGS
YEL/ RED
FUSE 4 8A
YEL/ RED
FRONT FUEL PUMP
BLK
BLK
REAR FUEL PUMP
BRN
BLK
GRY
KNOCK SENSOR
BREAKER
YEL
GRN
BLK
BRN
BLK
ORG
1
2
6
10
7
3
5
9
ENGINE CONTROL MODULE
8
IGNITION SWITCH
BLU/ YEL
FUSE 13 8A
BLU/ RED
CHARGE INDICATOR LIGHT
RED
BLU
BLU (M/T)
INHIBITOR SWITCH (A/T)
BLU
BLU/ YEL
JUNCTION BLOCK
RED
STARTER MOTOR
BLU
RED
RED
RED
NCA
BATTERY
ALTERNATOR
YEL/RED
RED/ BLK
BLK
TEMPERATURE SENSOR
ORG
ORG
BRN/BLK
MASS AIR FLOW METER
BLK
YEL/ RED
LAMBDA-SOND
BLK
BLK
BLK
BLU
ORG
BLU/ WHT
BLK
YEL
GRN/ YEL
WHT/ RED
WHT
BLK
GRN
BLK
GRN
2
3
12
25
14
6
7
8
11
20
19
5
FUEL INJECTION MODULE (LH-JETRONIC)
9
21
17
1
10
23
13
22
18
16
RED/ BLK
HOT AT ALL TIMES
FUSE 6 8A
RED
GRY
ORG
BRN
YEL/ BLK
BLU/ GRN
GRN/
BRN
IDLE SOLENOID
PNK
TO TEST CONNECTOR
RED
TO A/C SYSTEM
GRN/WHT
MAIN RELAY
YEL/ RED
YEL/RED
BRN/WHT
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR

Fig. 116 Chassis wiring — 1986 240 GL, DL and wagon (2.3L)

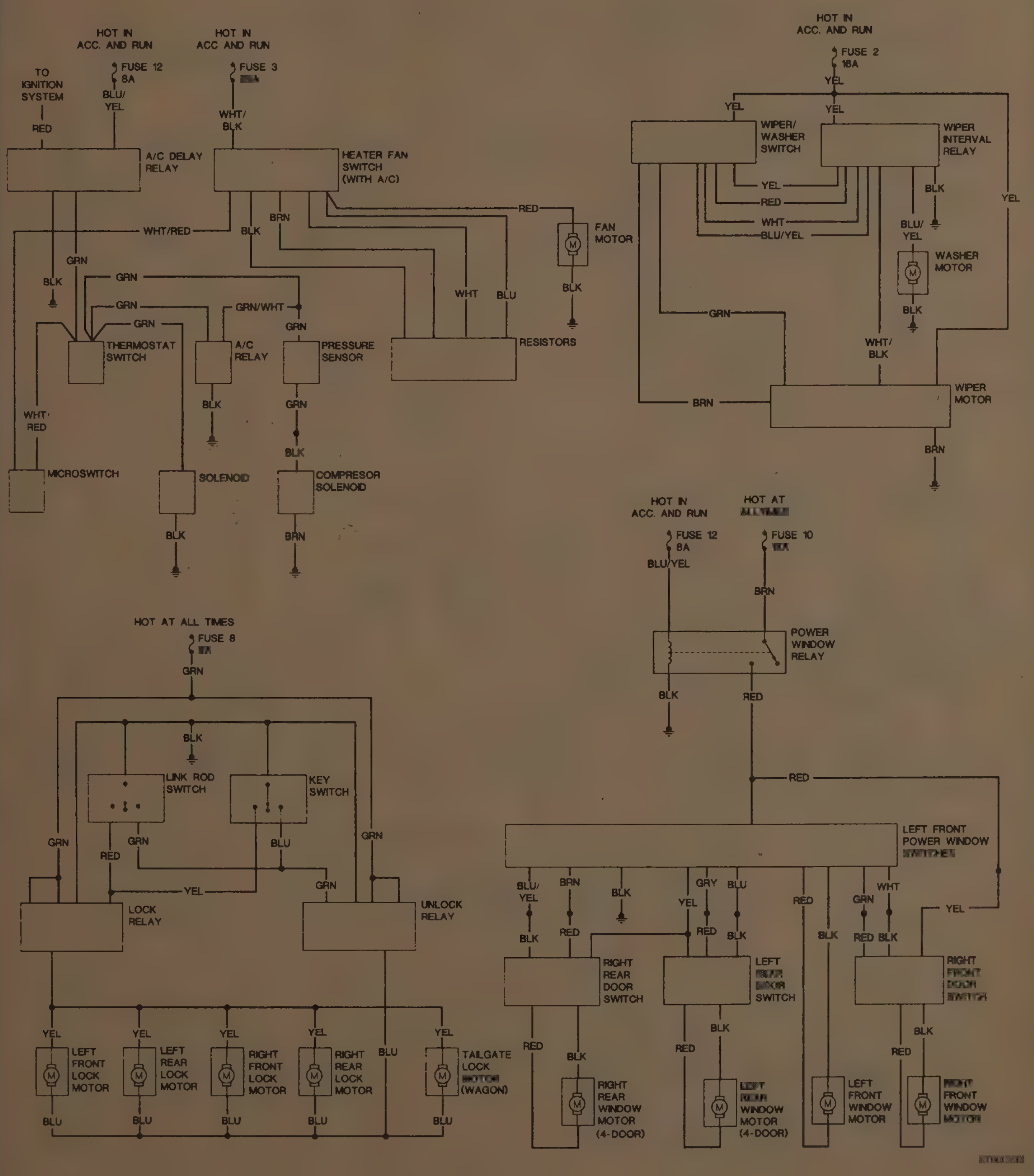

HOT IN ACC. AND RUN
FUSE 12 8A
TO IGNITION SYSTEM
RED
BLU/YEL
A/C DELAY RELAY
HOT IN ACC AND RUN
FUSE 3
WHT/BLK
HEATER FAN SWITCH (WITH A/C)
WHT/RED
BLK
BRN
GRN
RED
FAN MOTOR
M
BLK
GRN
GRN
GRN/WHT
GRN
WHT
BLU
THERMOSTAT SWITCH
A/C RELAY
PRESSURE SENSOR
RESISTORS
WHT/RED
BLK
GRN
BLK
MICROSWITCH
SOLENOID
COMPRESOR SOLENOID
BLK
BRN
HOT IN ACC. AND RUN
FUSE 2 16A
YEL
WIPER/WASHER SWITCH
WIPER INTERVAL RELAY
YEL
RED
WHT
BLU/YEL
BLK
BLU/YEL
WASHER MOTOR
GRN
WHT/BLK
BRN
WIPER MOTOR
HOT IN ACC. AND RUN
HOT AT ALL TIMES
FUSE 12 8A
FUSE 10
BLU/YEL
BRN
POWER WINDOW RELAY
BLK
RED
RED
LEFT FRONT POWER WINDOW SWITCHES
BLU/YEL
BRN
BLK
GRY
BLU
YEL
RED
GRN
WHT
YEL
BLK
RED
RED
BLK
BLK
RED BLK
RIGHT REAR DOOR SWITCH
LEFT REAR DOOR SWITCH
RIGHT FRONT DOOR SWITCH
RED
BLK
RED
BLK
RED
BLK
RIGHT REAR WINDOW MOTOR (4-DOOR)
LEFT REAR WINDOW MOTOR (4-DOOR)
LEFT FRONT WINDOW MOTOR
RIGHT FRONT WINDOW MOTOR
HOT AT ALL TIMES
FUSE 8
GRN
BLK
LINK ROD SWITCH
KEY SWITCH
GRN
RED
GRN
BLU
GRN
YEL
GRN
LOCK RELAY
UNLOCK RELAY
YEL
LEFT FRONT LOCK MOTOR
LEFT REAR LOCK MOTOR
RIGHT FRONT LOCK MOTOR
RIGHT REAR LOCK MOTOR
BLU
TAILGATE LOCK MOTOR (WAGON)
BLU

Fig. 117 Chassis wiring — 1986 240 DL, GL and wagon

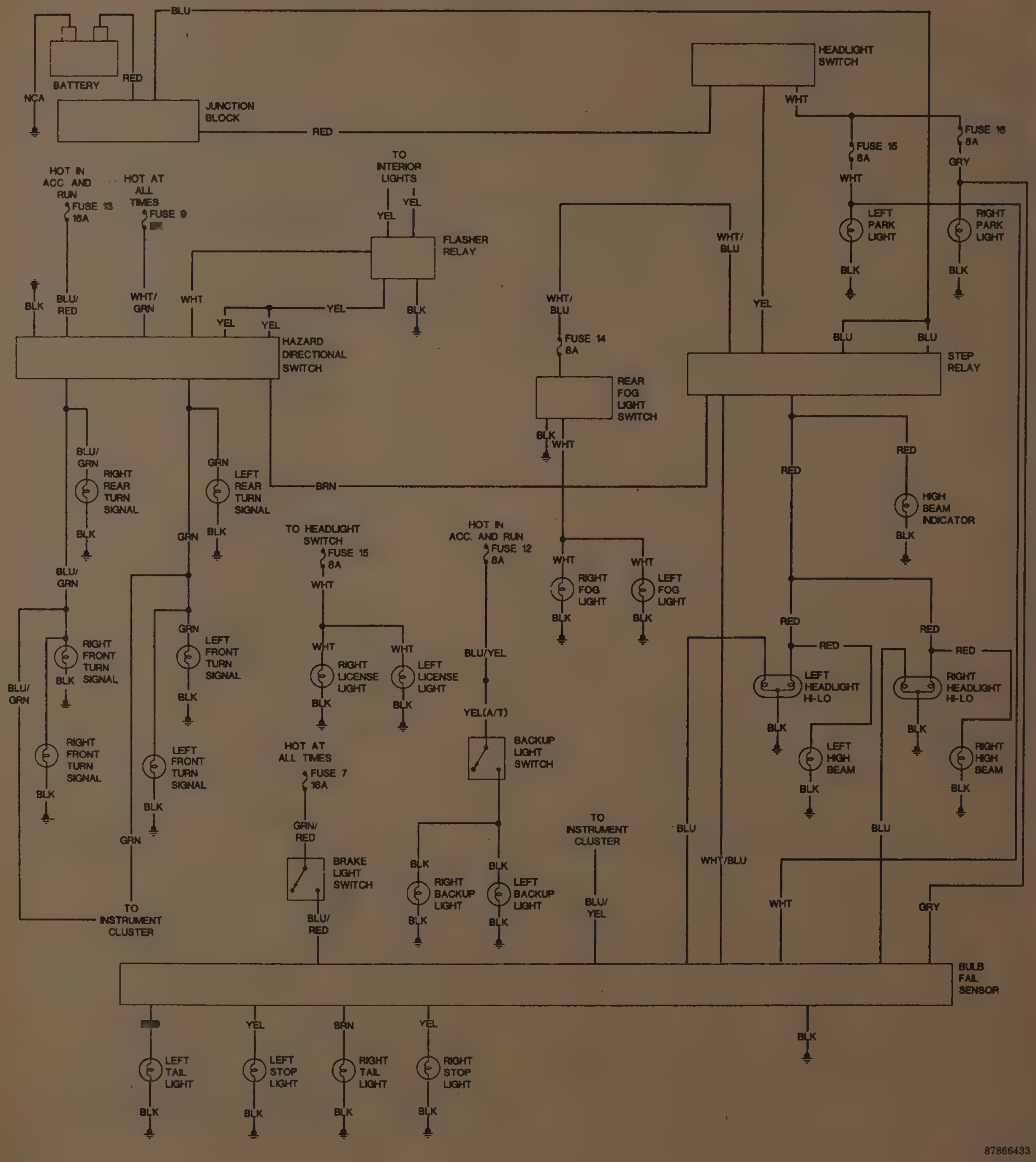

BLU
BATTERY
RED
NCA
JUNCTION BLOCK
RED
HEADLIGHT SWITCH
WHT
FUSE 16 8A
FUSE 15 8A
GRY
WHT
LEFT PARK LIGHT
RIGHT PARK LIGHT
BLK
BLK
TO INTERIOR LIGHTS
YEL
YEL
FLASHER RELAY
HOT IN ACC AND RUN
FUSE 13 16A
HOT AT ALL TIMES
FUSE 9
BLK
BLU/ RED
WHT/ GRN
WHT
YEL
YEL
YEL
BLK
HAZARD DIRECTIONAL SWITCH
WHT/ BLU
WHT/ BLU
YEL
FUSE 14 8A
REAR FOG LIGHT SWITCH
BLK
WHT
BLU
BLU
STEP RELAY
BLU/ GRN
RIGHT REAR TURN SIGNAL
BLK
GRN
LEFT REAR TURN SIGNAL
BLK
GRN
BRN
RED
RED
HIGH BEAM INDICATOR
BLK
BLU/ GRN
TO HEADLIGHT SWITCH
FUSE 15 8A
WHT
HOT IN ACC. AND RUN
FUSE 12 8A
WHT
WHT
RIGHT FOG LIGHT
LEFT FOG LIGHT
BLK
BLK
RED
RED
RED
RED
RIGHT FRONT TURN SIGNAL
BLK
GRN
LEFT FRONT TURN SIGNAL
BLK
WHT
WHT
RIGHT LICENSE LIGHT
LEFT LICENSE LIGHT
BLK
BLK
BLU/YEL
LEFT HEADLIGHT HI-LO
RIGHT HEADLIGHT HI-LO
BLK
BLK
BLU/ GRN
RIGHT FRONT TURN SIGNAL
BLK
LEFT FRONT TURN SIGNAL
BLK
YEL(A/T)
BACKUP LIGHT SWITCH
HOT AT ALL TIMES
FUSE 7 16A
LEFT HIGH BEAM
BLK
RIGHT HIGH BEAM
BLK
GRN
GRN/ RED
BRAKE LIGHT SWITCH
BLK
BLK
RIGHT BACKUP LIGHT
LEFT BACKUP LIGHT
BLK
BLK
TO INSTRUMENT CLUSTER
BLU
BLU
WHT/BLU
WHT
GRY
TO INSTRUMENT CLUSTER
BLU/ RED
BLU/ YEL
BULB FAIL SENSOR
YEL
BRN
YEL
BLK
LEFT TAIL LIGHT
LEFT STOP LIGHT
RIGHT TAIL LIGHT
RIGHT STOP LIGHT
BLK
BLK
BLK
BLK
87866433

Fig. 118 Chassis wiring — 1986 240 DL, GL and wagon (continued)

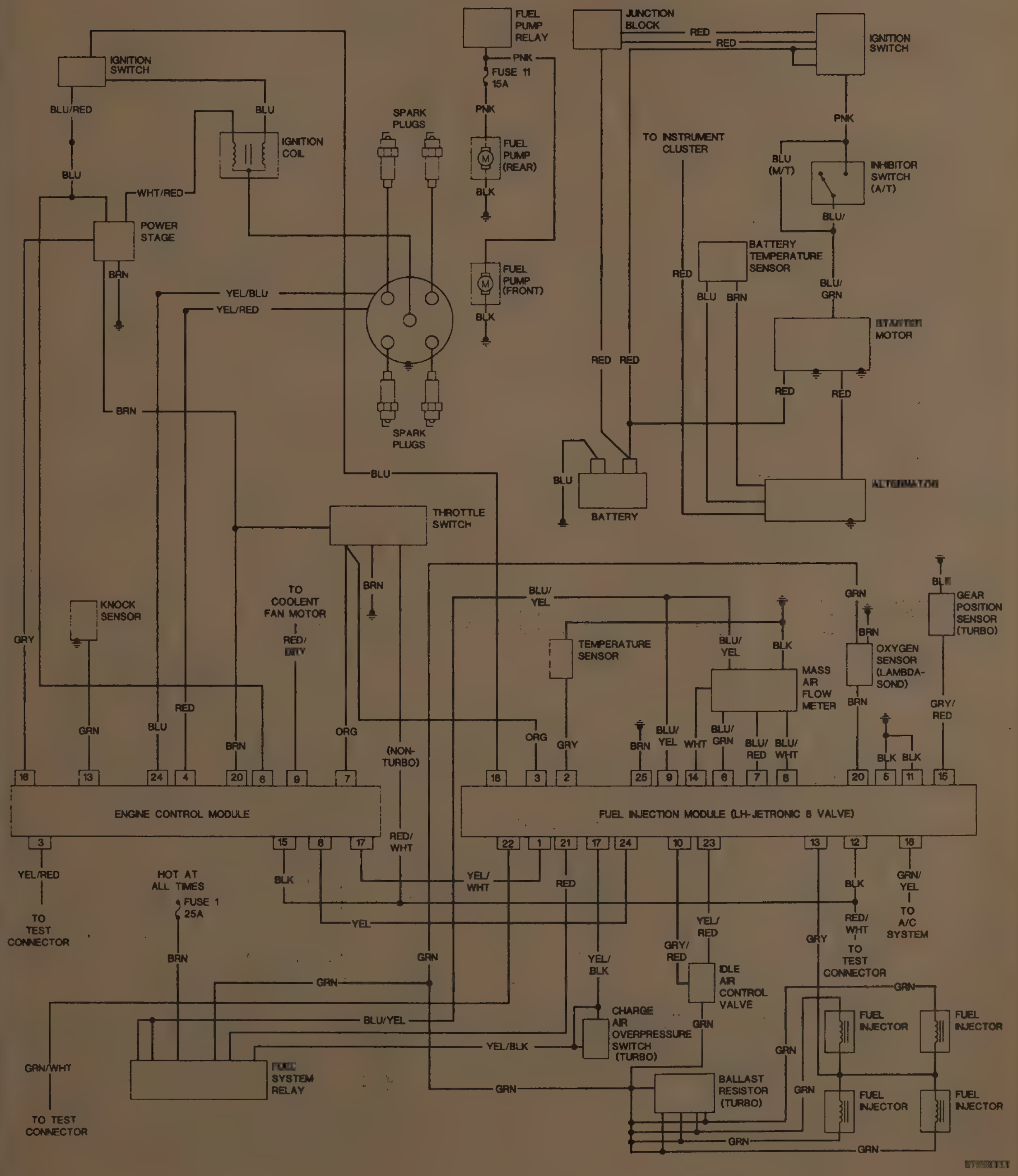

IGNITION SWITCH
BLU/RED
BLU
BLU
IGNITION COIL
WHT/RED
POWER STAGE
BRN
YEL/BLU
YEL/RED
BRN
SPARK PLUGS
SPARK PLUGS
FUEL PUMP RELAY
PNK
FUSE 11 15A
PNK
FUEL PUMP (REAR)
BLK
FUEL PUMP (FRONT)
BLK
JUNCTION BLOCK
RED
RED
IGNITION SWITCH
PNK
TO INSTRUMENT CLUSTER
BLU (M/T)
INHIBITOR SWITCH (A/T)
BLU/
BATTERY TEMPERATURE SENSOR
RED
BLU
BRN
BLU/ GRN
STARTER MOTOR
RED
RED
RED
RED
BLU
BATTERY
ALTERNATOR
BLU
THROTTLE SWITCH
BRN
KNOCK SENSOR
TO COOLENT FAN MOTOR
RED/ GRY
GRY
GRN
BLU
RED
BRN
ORG
(NON-TURBO)
BLU/ YEL
TEMPERATURE SENSOR
ORG
GRY
BLU/ YEL
BLK
MASS AIR FLOW METER
GRN
BLK
BRN
OXYGEN SENSOR (LAMBDA-SOND)
BRN
GEAR POSITION SENSOR (TURBO)
GRY/ RED
BRN
BLU/ YEL
WHT
BLU/ GRN
BLU/ RED
BLU/ WHT
BLK
BLK
16
13
24
4
20
6
9
7
ENGINE CONTROL MODULE
3
15
8
17
RED/ WHT
18
3
2
25
9
14
6
7
8
20
5
11
15
FUEL INJECTION MODULE (LH-JETRONIC 8 VALVE)
22
1
21
17
24
10
23
13
12
16
YEL/RED
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 1 25A
BRN
BLK
YEL/ WHT
YEL
RED
GRN
GRN
BLU/YEL
YEL/ BLK
YEL/ RED
GRY/ RED
BLK
RED/ WHT
TO TEST CONNECTOR
GRY
GRN/ YEL
TO A/C SYSTEM
IDLE AIR CONTROL VALVE
GRN
CHARGE AIR OVERPRESSURE SWITCH (TURBO)
YEL/BLK
GRN
FUEL INJECTOR
FUEL INJECTOR
GRN
GRN/WHT
TO TEST CONNECTOR
FUEL SYSTEM RELAY
GRN
BALLAST RESISTOR (TURBO)
GRN
FUEL INJECTOR
FUEL INJECTOR
GRN
GRN

Fig. 119 Engine wiring — 1986 740 and 760 GL/GLE sedan and wagon (2.3L LH-Jetronic turbo and normally aspirated)

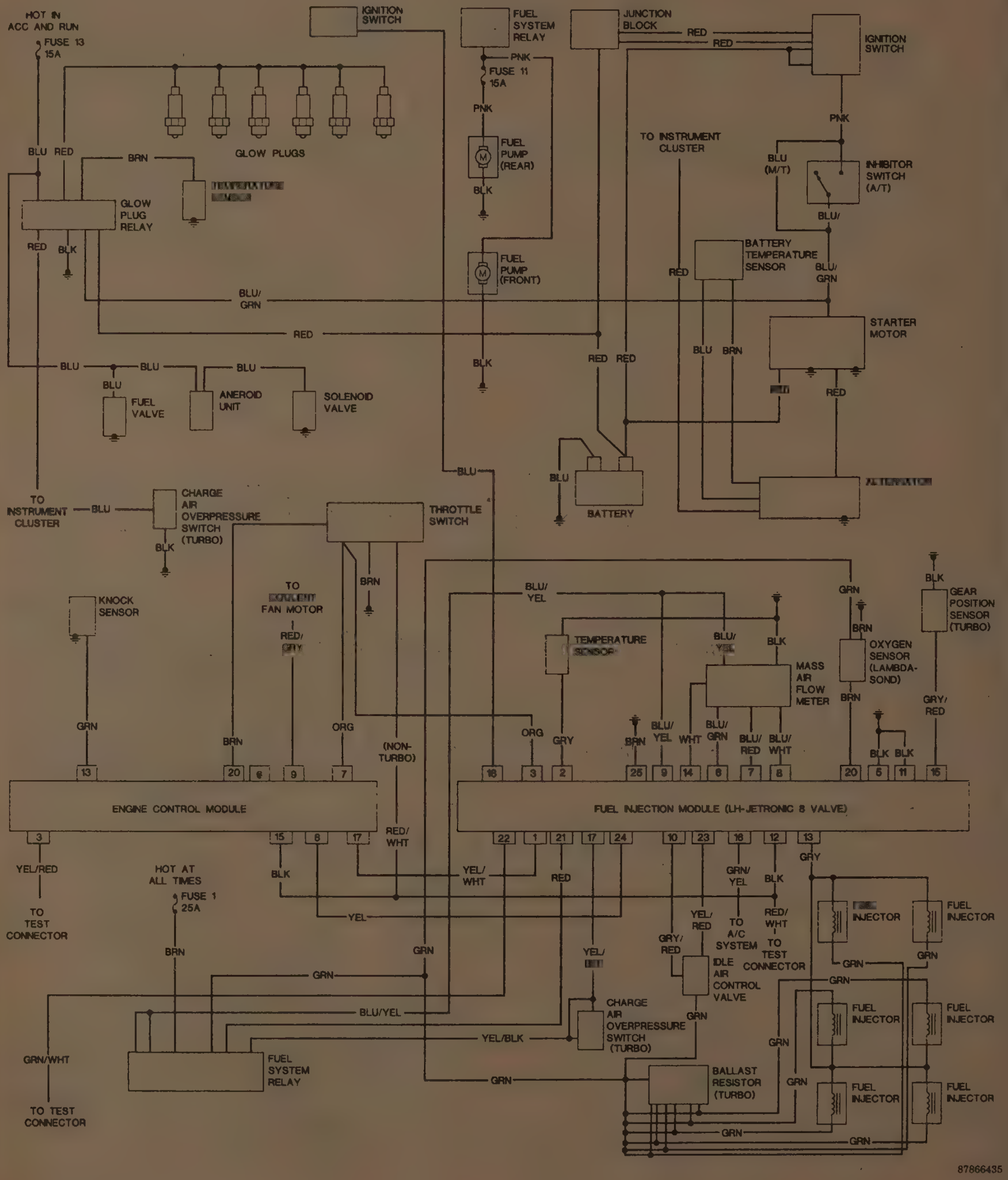

HOT IN ACC AND RUN
FUSE 13 15A
IGNITION SWITCH
FUEL SYSTEM RELAY
PNK
FUSE 11 15A
JUNCTION BLOCK
RED
RED
IGNITION SWITCH
GLOW PLUGS
BLU
RED
BRN
TEMPERATURE SENSOR
GLOW PLUG RELAY
RED
BLK
FUEL PUMP (REAR)
BLK
TO INSTRUMENT CLUSTER
PNK
BLU (M/T)
INHIBITOR SWITCH (A/T)
BLU/
BATTERY TEMPERATURE SENSOR
BLU/ GRN
FUEL PUMP (FRONT)
BLU/ GRN
RED
STARTER MOTOR
BLK
RED
RED
BLU
BRN
BLU
BLU
BLU
BLU
FUEL VALVE
ANEROID UNIT
SOLENOID VALVE
RED
BLU
BATTERY
ALTERNATOR
TO INSTRUMENT CLUSTER
BLU
CHARGE AIR OVERPRESSURE SWITCH (TURBO)
BLK
THROTTLE SWITCH
BRN
TO COOLANT FAN MOTOR
RED/ GRY
KNOCK SENSOR
BLU/ YEL
TEMPERATURE SENSOR
BLU/ YEL
BLK
MASS AIR FLOW METER
GRN
BRN
OXYGEN SENSOR (LAMBDA-SOND)
BLK
GEAR POSITION SENSOR (TURBO)
GRN
BRN
ORG
(NON-TURBO)
ORG
GRY
BRN
BLU/ YEL
WHT
BLU/ GRN
BLU/ RED
BLU/ WHT
BRN
BLK
BLK
GRY/ RED
13
20
e
9
7
ENGINE CONTROL MODULE
18
3
2
25
9
14
6
7
8
20
5
11
15
FUEL INJECTION MODULE (LH-JETRONIC 8 VALVE)
3
15
8
17
RED/ WHT
22
1
21
17
24
10
23
16
12
13
GRY
YEL/RED
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 1 25A
BLK
YEL/ WHT
RED
GRN/ YEL
BLK
YEL
FUEL INJECTOR
FUEL INJECTOR
BRN
GRN
YEL/ RED
TO A/C SYSTEM
RED/ WHT
TO TEST CONNECTOR
GRY/ RED
YEL/ BLK
IDLE AIR CONTROL VALVE
GRN
GRN
GRN
GRN
BLU/YEL
CHARGE AIR OVERPRESSURE SWITCH (TURBO)
GRN
FUEL INJECTOR
FUEL INJECTOR
YEL/BLK
GRN
GRN/WHT
FUEL SYSTEM RELAY
GRN
BALLAST RESISTOR (TURBO)
GRN
FUEL INJECTOR
FUEL INJECTOR
TO TEST CONNECTOR
GRN
GRN
87866435

Fig. 120 Engine wiring — 1986 740 and 760 diesel turbo and normally aspirated (2.8L)

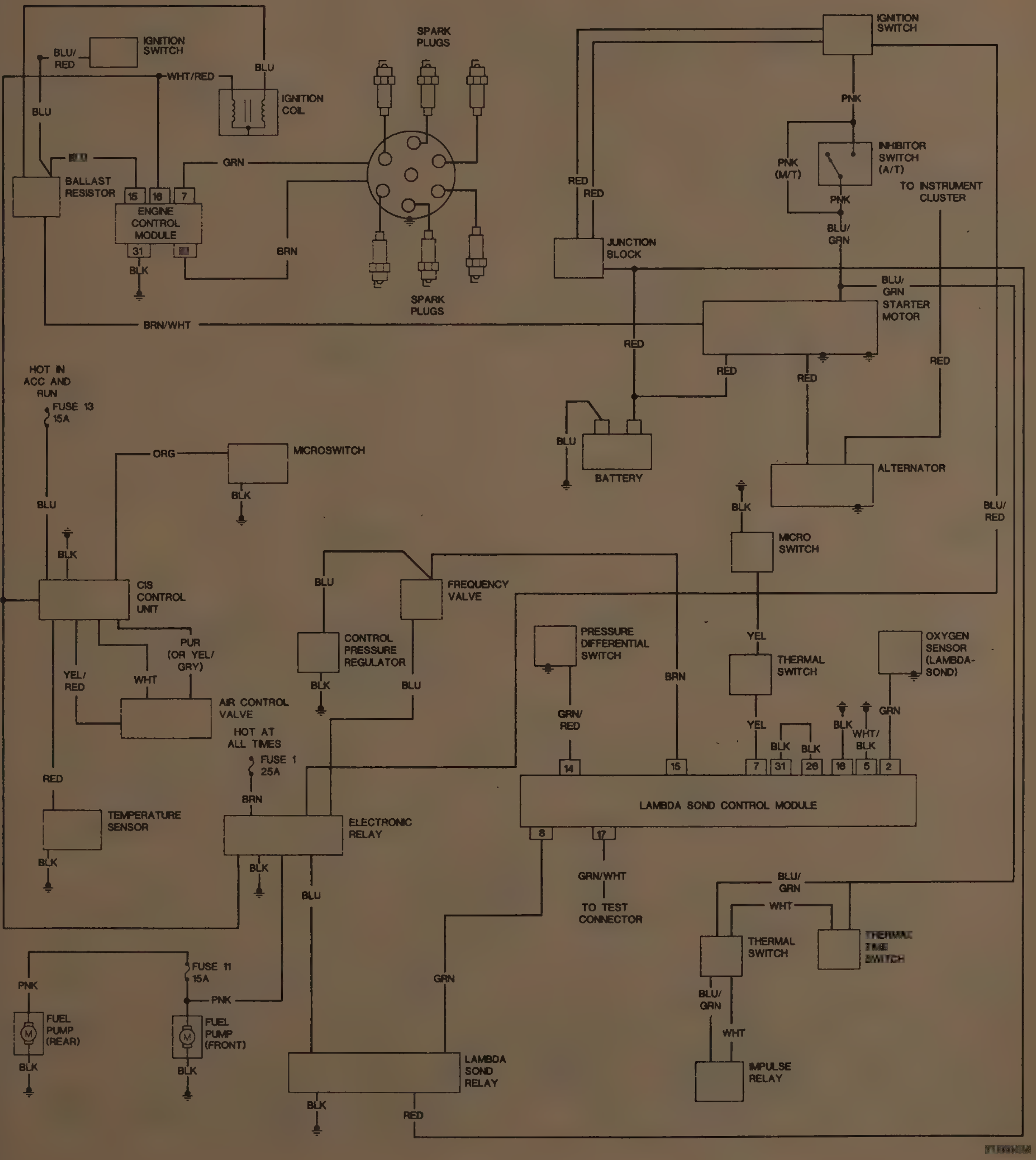

IGNITION SWITCH
BLU/ RED
BLU
WHT/RED
IGNITION COIL
BLU
SPARK PLUGS
GRN
BALLAST RESISTOR
15
16
7
ENGINE CONTROL MODULE
31
BLK
BRN
SPARK PLUGS
BRN/WHT
IGNITION SWITCH
PNK
INHIBITOR SWITCH (A/T)
PNK (M/T)
PNK
TO INSTRUMENT CLUSTER
RED
RED
JUNCTION BLOCK
BLU/ GRN
BLU/ GRN
STARTER MOTOR
RED
RED
RED
RED
BLU
BATTERY
ALTERNATOR
BLU/ RED
HOT IN ACC AND RUN
FUSE 13 15A
ORG
MICROSWITCH
BLK
BLU
BLK
CIS CONTROL UNIT
YEL/ RED
WHT
PUR (OR YEL/ GRY)
AIR CONTROL VALVE
BLU
CONTROL PRESSURE REGULATOR
BLK
BLU
FREQUENCY VALVE
BLK
MICRO SWITCH
PRESSURE DIFFERENTIAL SWITCH
GRN/ RED
BRN
YEL
THERMAL SWITCH
YEL
OXYGEN SENSOR (LAMBDA-SOND)
GRN
BLK
BLK
BLK
WHT/ BLK
14
15
7
31
26
18
5
2
LAMBDA SOND CONTROL MODULE
8
17
GRN/WHT
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 1 25A
BRN
RED
TEMPERATURE SENSOR
BLK
ELECTRONIC RELAY
BLK
BLU
BLU/ GRN
WHT
THERMAL SWITCH
THERMAL TIME SWITCH
BLU/ GRN
WHT
IMPULSE RELAY
PNK
FUSE 11 15A
PNK
FUEL PUMP (REAR)
M
BLK
FUEL PUMP (FRONT)
M
BLK
GRN
LAMBDA SOND RELAY
BLK
RED

Fig. 121 Engine wiring — 760 GLE and 780 coupe (2.8L)

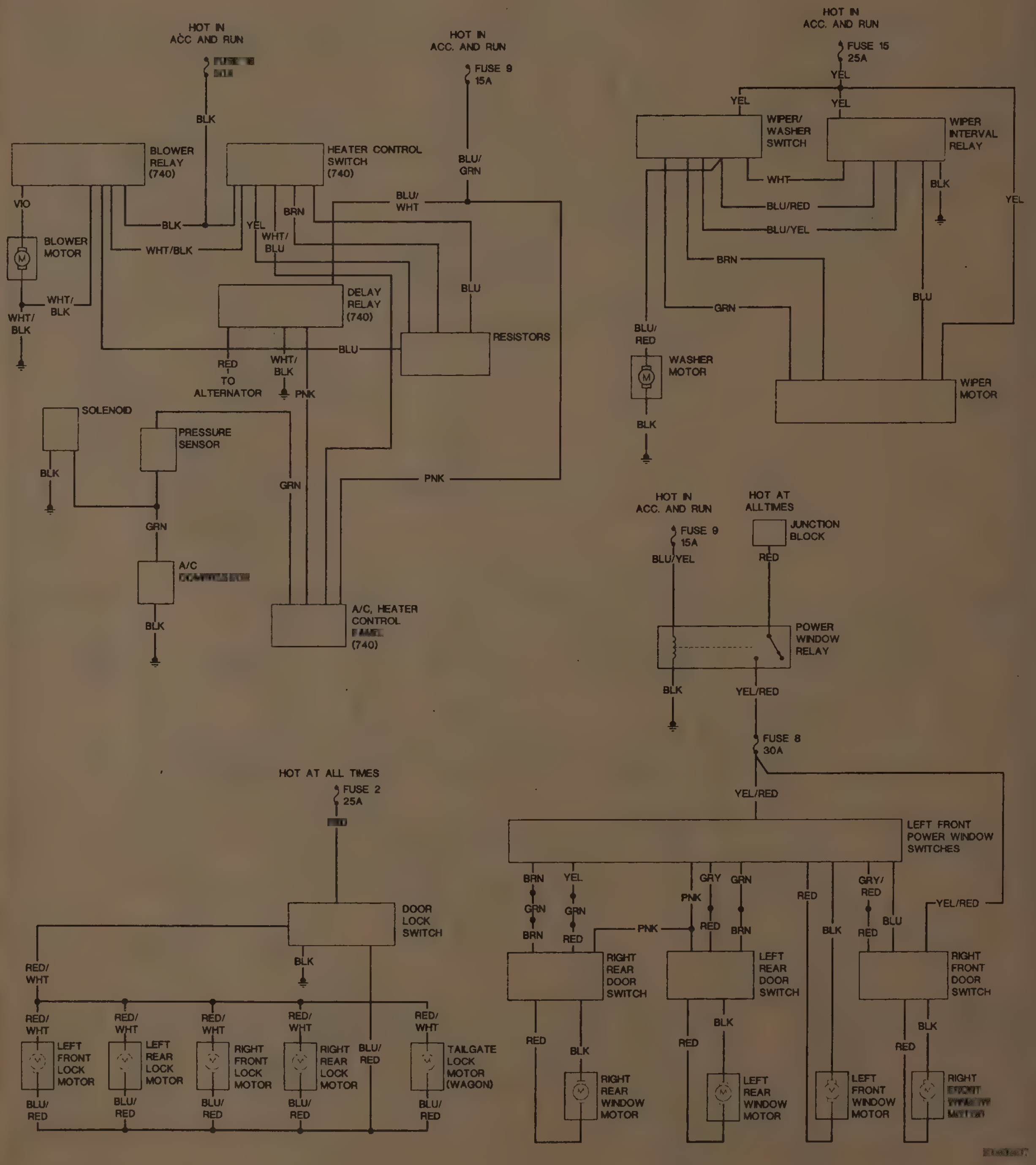

HOT IN ACC. AND RUN
BLK
BLOWER RELAY (740)
HEATER CONTROL SWITCH (740)
HOT IN ACC. AND RUN
FUSE 9 15A
BLU/ GRN
BLU/ WHT
VIO
BLK
BRN
YEL
WHT/ BLU
WHT/BLK
BLOWER MOTOR
WHT/ BLK
WHT/ BLK
DELAY RELAY (740)
BLU
BLU
RESISTORS
RED TO ALTERNATOR
WHT/ BLK
PNK
SOLENOID
PRESSURE SENSOR
BLK
GRN
PNK
GRN
A/C
BLK
A/C, HEATER CONTROL (740)
HOT IN ACC. AND RUN
FUSE 15 25A
YEL
YEL
YEL
WIPER/ WASHER SWITCH
WIPER INTERVAL RELAY
WHT
BLK
YEL
BLU/RED
BLU/YEL
BRN
GRN
BLU
BLU/ RED
WASHER MOTOR
WIPER MOTOR
BLK
HOT IN ACC. AND RUN
HOT AT ALLTIMES
FUSE 9 15A
JUNCTION BLOCK
BLU/YEL
RED
POWER WINDOW RELAY
BLK
YEL/RED
FUSE 8 30A
YEL/RED
HOT AT ALL TIMES
FUSE 2 25A
DOOR LOCK SWITCH
RED/ WHT
BLK
RED/ WHT
LEFT FRONT LOCK MOTOR
RED/ WHT
LEFT REAR LOCK MOTOR
RED/ WHT
RIGHT FRONT LOCK MOTOR
RED/ WHT
RIGHT REAR LOCK MOTOR
BLU/ RED
RED/ WHT
TAILGATE LOCK MOTOR (WAGON)
BLU/ RED
BLU/ RED
BLU/ RED
BLU/ RED
BLU/ RED
LEFT FRONT POWER WINDOW SWITCHES
BRN
YEL
GRY
GRN
GRY/ RED
PNK
RED
YEL/RED
GRN
GRN
BRN
RED
PNK
RED
BRN
BLK
RED
BLU
RIGHT REAR DOOR SWITCH
LEFT REAR DOOR SWITCH
RIGHT FRONT DOOR SWITCH
RED
BLK
RED
BLK
BLK
RED
RIGHT REAR WINDOW MOTOR
LEFT REAR WINDOW MOTOR
LEFT FRONT WINDOW MOTOR
RIGHT

Fig. 122 1986 740 and 760 GL/GLE sedan and wagon

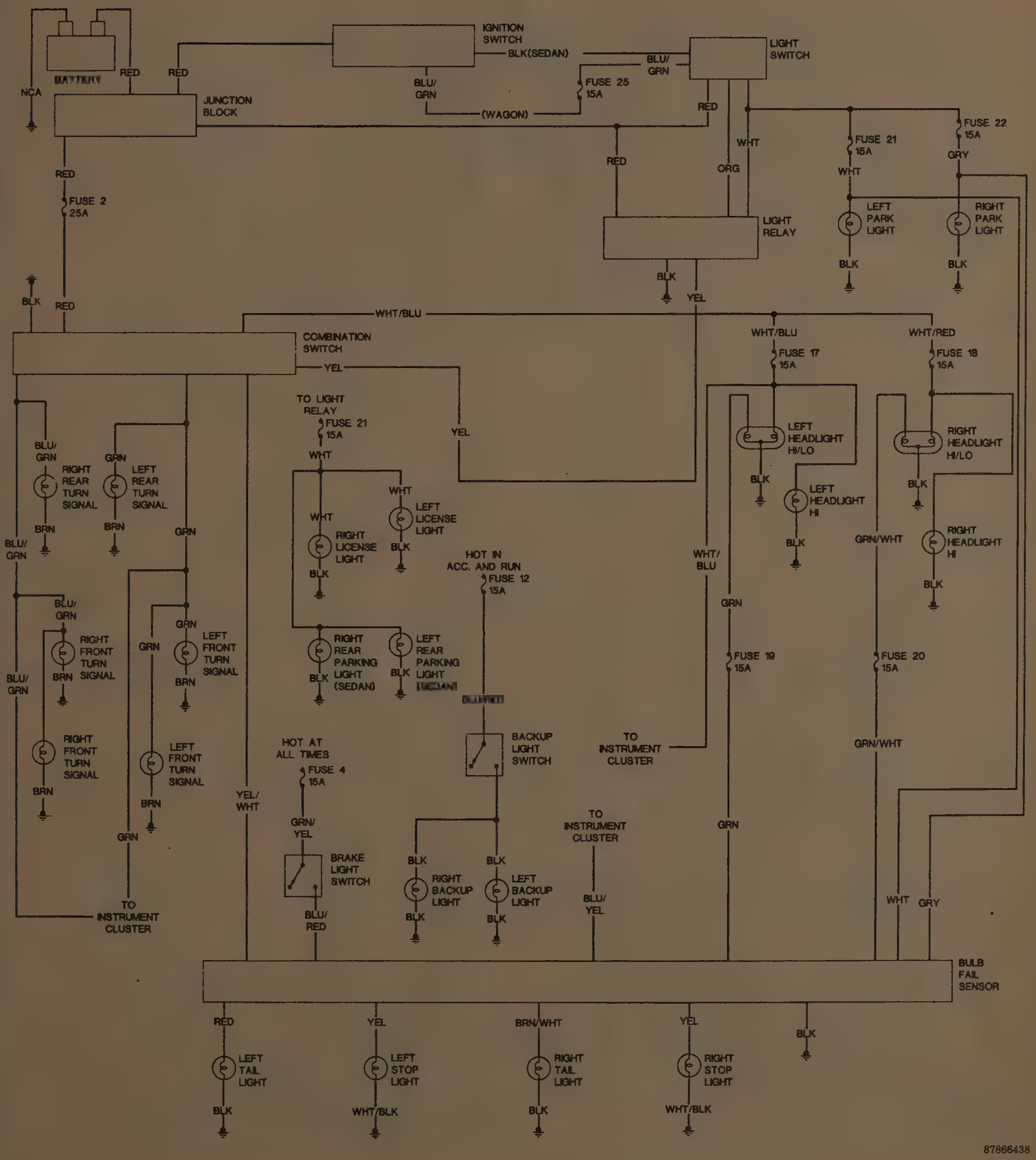

BATTERY
NCA
RED
RED
JUNCTION BLOCK
IGNITION SWITCH
BLK(SEDAN)
BLU/ GRN
(WAGON)
BLU/ GRN
FUSE 25 15A
LIGHT SWITCH
RED
WHT
ORG
RED
LIGHT RELAY
BLK
YEL
FUSE 21 15A
WHT
LEFT PARK LIGHT
BLK
FUSE 22 15A
GRY
RIGHT PARK LIGHT
BLK
RED
FUSE 2 25A
BLK
RED
WHT/BLU
COMBINATION SWITCH
YEL
WHT/BLU
FUSE 17 15A
WHT/RED
FUSE 18 15A
LEFT HEADLIGHT HI/LO
BLK
LEFT HEADLIGHT HI
BLK
RIGHT HEADLIGHT HI/LO
BLK
RIGHT HEADLIGHT HI
BLK
BLU/ GRN
RIGHT REAR TURN SIGNAL
BRN
GRN
LEFT REAR TURN SIGNAL
BRN
BLU/ GRN
GRN
TO LIGHT RELAY
FUSE 21 15A
WHT
YEL
WHT
LEFT LICENSE LIGHT
BLK
WHT
RIGHT LICENSE LIGHT
BLK
HOT IN ACC. AND RUN
FUSE 12 15A
WHT/ BLU
GRN
GRN/WHT
BLU/ GRN
RIGHT FRONT TURN SIGNAL
BRN
GRN
GRN
LEFT FRONT TURN SIGNAL
BRN
BLU/ GRN
RIGHT REAR PARKING LIGHT (SEDAN)
BLK
LEFT REAR PARKING LIGHT (SEDAN)
BLK
BLU/RED
FUSE 19 15A
FUSE 20 15A
RIGHT FRONT TURN SIGNAL
BRN
LEFT FRONT TURN SIGNAL
BRN
BACKUP LIGHT SWITCH
TO INSTRUMENT CLUSTER
GRN/WHT
HOT AT ALL TIMES
FUSE 4 15A
YEL/ WHT
GRN
GRN/ YEL
BRAKE LIGHT SWITCH
BLU/ RED
BLK
RIGHT BACKUP LIGHT
BLK
BLK
LEFT BACKUP LIGHT
BLK
TO INSTRUMENT CLUSTER
BLU/ YEL
GRN
WHT
GRY
TO INSTRUMENT CLUSTER
BULB FAIL SENSOR
RED
LEFT TAIL LIGHT
BLK
YEL
LEFT STOP LIGHT
WHT/BLK
BRN/WHT
RIGHT TAIL LIGHT
BLK
YEL
RIGHT STOP LIGHT
WHT/BLK
BLK
87866438

Fig. 123 1986 740 and 760 GL/GLE sedan and wagon (continued)

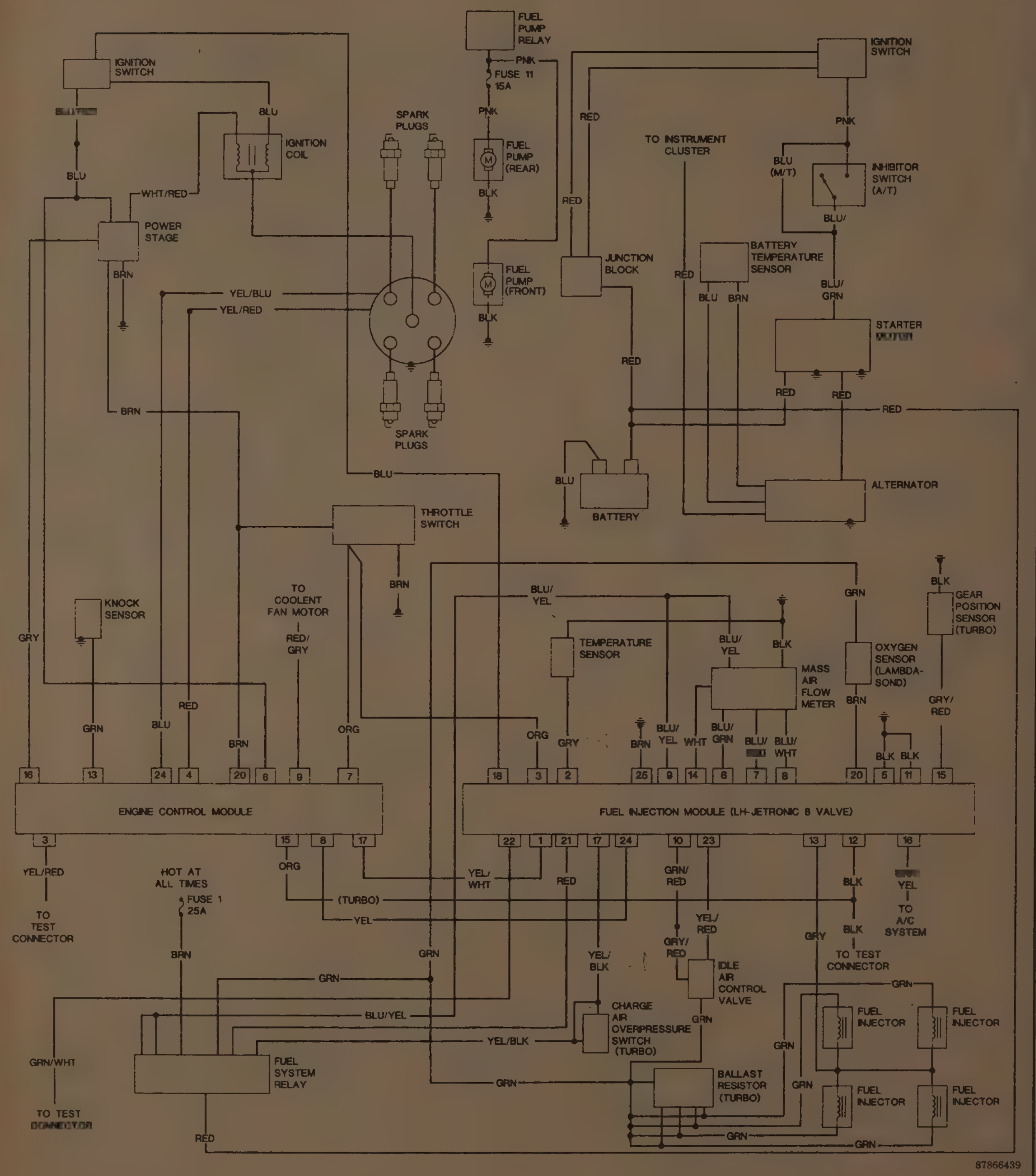
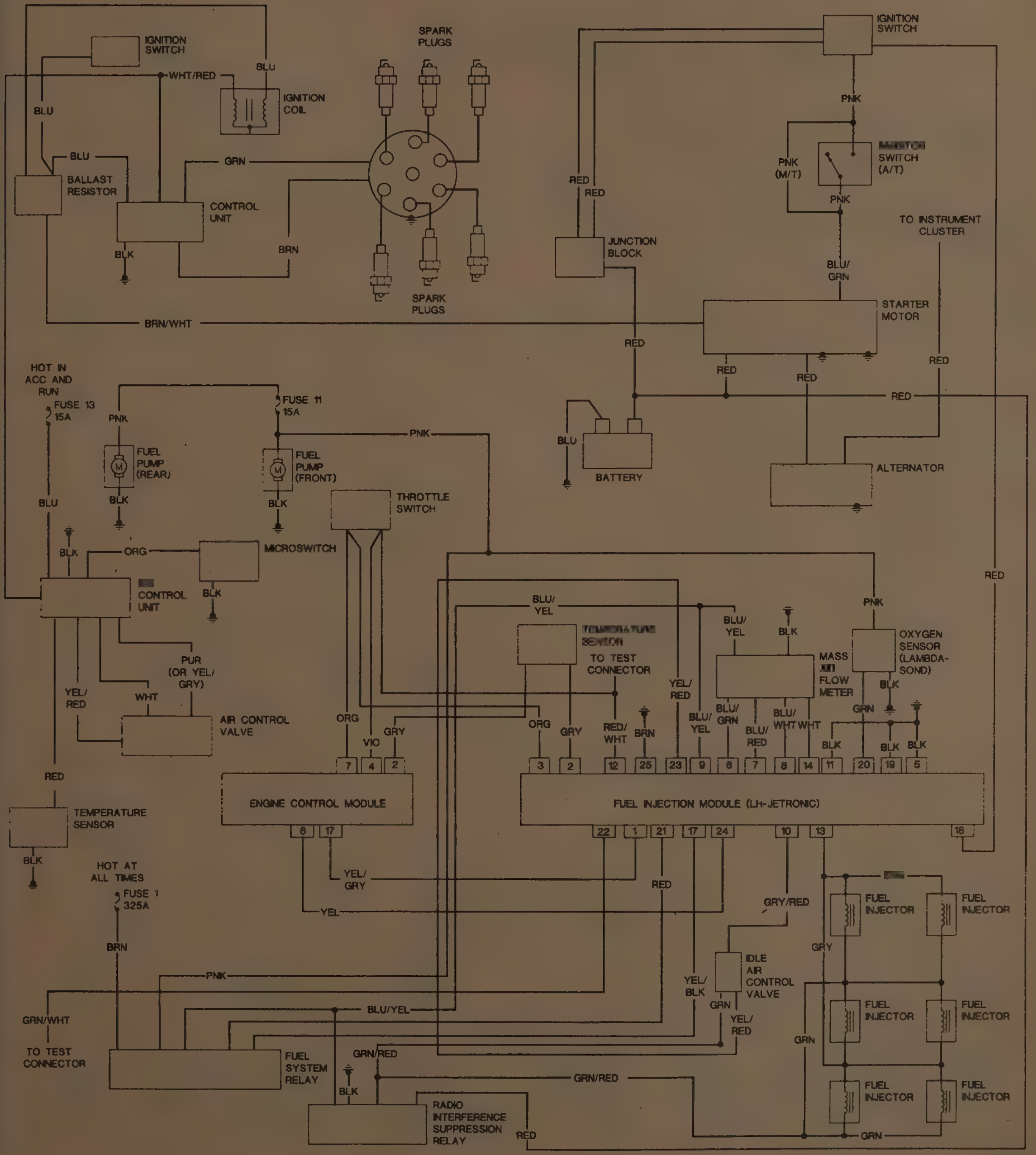

IGNITION SWITCH
BLU
BLU
IGNITION COIL
WHT/RED
POWER STAGE
BRN
SPARK PLUGS
SPARK PLUGS
YEL/BLU
YEL/RED
FUEL PUMP RELAY
PNK
FUSE 11 15A
PNK
FUEL PUMP (REAR)
BLK
FUEL PUMP (FRONT)
BLK
RED
RED
IGNITION SWITCH
PNK
TO INSTRUMENT CLUSTER
BLU (M/T)
INHIBITOR SWITCH (A/T)
BLU/
JUNCTION BLOCK
RED
BATTERY TEMPERATURE SENSOR
BLU
BRN
BLU/ GRN
STARTER
RED
RED
RED
RED
BLU
BATTERY
ALTERNATOR
BRN
BLU
THROTTLE SWITCH
BRN
TO COOLENT FAN MOTOR
RED/ GRY
KNOCK SENSOR
GRY
GRN
BLU
RED
BRN
ORG
BLU/ YEL
GRN
BLK
GEAR POSITION SENSOR (TURBO)
TEMPERATURE SENSOR
BLU/ YEL
BLK
MASS AIR FLOW METER
OXYGEN SENSOR (LAMBDA-SOND)
BRN
GRY/ RED
ORG
GRY
BRN
BLU/ YEL
WHT
BLU/ GRN
BLU/
BLU/ WHT
BLK
BLK
16
13
24
4
20
6
9
7
18
3
2
25
9
14
6
7
8
20
5
11
15
ENGINE CONTROL MODULE
FUEL INJECTION MODULE (LH-JETRONIC 8 VALVE)
3
15
8
17
22
1
21
17
24
10
23
13
12
16
YEL/RED
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 1 25A
BRN
ORG
(TURBO)
YEL
YEL/ WHT
RED
GRN/ RED
BLK
YEL
TO A/C SYSTEM
YEL/ RED
GRY/ RED
GRY
BLK
TO TEST CONNECTOR
GRN
GRN
YEL/ BLK
IDLE AIR CONTROL VALVE
BLU/YEL
CHARGE AIR OVERPRESSURE SWITCH (TURBO)
GRN
YEL/BLK
GRN/WHT
TO TEST
FUEL SYSTEM RELAY
GRN
BALLAST RESISTOR (TURBO)
GRN
GRN
GRN
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
GRN
GRN
RED
87866439

Fig. 124 Engine wiring — 1987 740 GL/GLE sedan and wagon (2.3L LH-Jetronic turbo and normally aspirated)


IGNITION SWITCH
WHT/RED
BLU
IGNITION COIL
BLU
BLU
BALLAST RESISTOR
GRN
CONTROL UNIT
BLK
BRN
SPARK PLUGS
SPARK PLUGS
BRN/WHT
IGNITION SWITCH
PNK
PNK (M/T)
SWITCH (A/T)
PNK
RED
RED
JUNCTION BLOCK
BLU/ GRN
TO INSTRUMENT CLUSTER
STARTER MOTOR
RED
RED
RED
RED
RED
BLU
BATTERY
ALTERNATOR
HOT IN ACC AND RUN
FUSE 13 15A
PNK
FUSE 11 15A
PNK
FUEL PUMP (REAR)
FUEL PUMP (FRONT)
BLK
BLK
BLU
THROTTLE SWITCH
BLK
ORG
MICROSWITCH
CONTROL UNIT
BLK
RED
BLU/ YEL
TO TEST CONNECTOR
BLU/ YEL
BLK
PNK
MASS AIR FLOW METER
OXYGEN SENSOR (LAMBDA-SOND)
BLK
PUR (OR YEL/ GRY)
YEL/ RED
WHT
AIR CONTROL VALVE
ORG
VIO
GRY
ORG
GRY
RED/ WHT
BRN
YEL/ RED
BLU/ YEL
BLU/ GRN
BLU/ RED
BLU/ WHT
WHT
GRN
BLK
BLK
BLK
7
4
2
3
2
12
25
23
9
6
7
8
14
11
20
19
5
ENGINE CONTROL MODULE
FUEL INJECTION MODULE (LH-JETRONIC)
8
17
22
1
21
17
24
10
13
18
RED
TEMPERATURE SENSOR
BLK
HOT AT ALL TIMES
FUSE 1 325A
BRN
YEL/ GRY
YEL
RED
GRY/RED
FUEL INJECTOR
FUEL INJECTOR
GRY
IDLE AIR CONTROL VALVE
YEL/ BLK
GRN
YEL/ RED
FUEL INJECTOR
FUEL INJECTOR
GRN
PNK
GRN/WHT
TO TEST CONNECTOR
BLU/YEL
FUEL SYSTEM RELAY
GRN/RED
BLK
GRN/RED
RADIO INTERFERENCE SUPPRESSION RELAY
RED
FUEL INJECTOR
FUEL INJECTOR
GRN

87866440

Fig. 125 Engine wiring — 1987 760 GLE sedan and 780 coupe (2.8L LH-Jetronic)

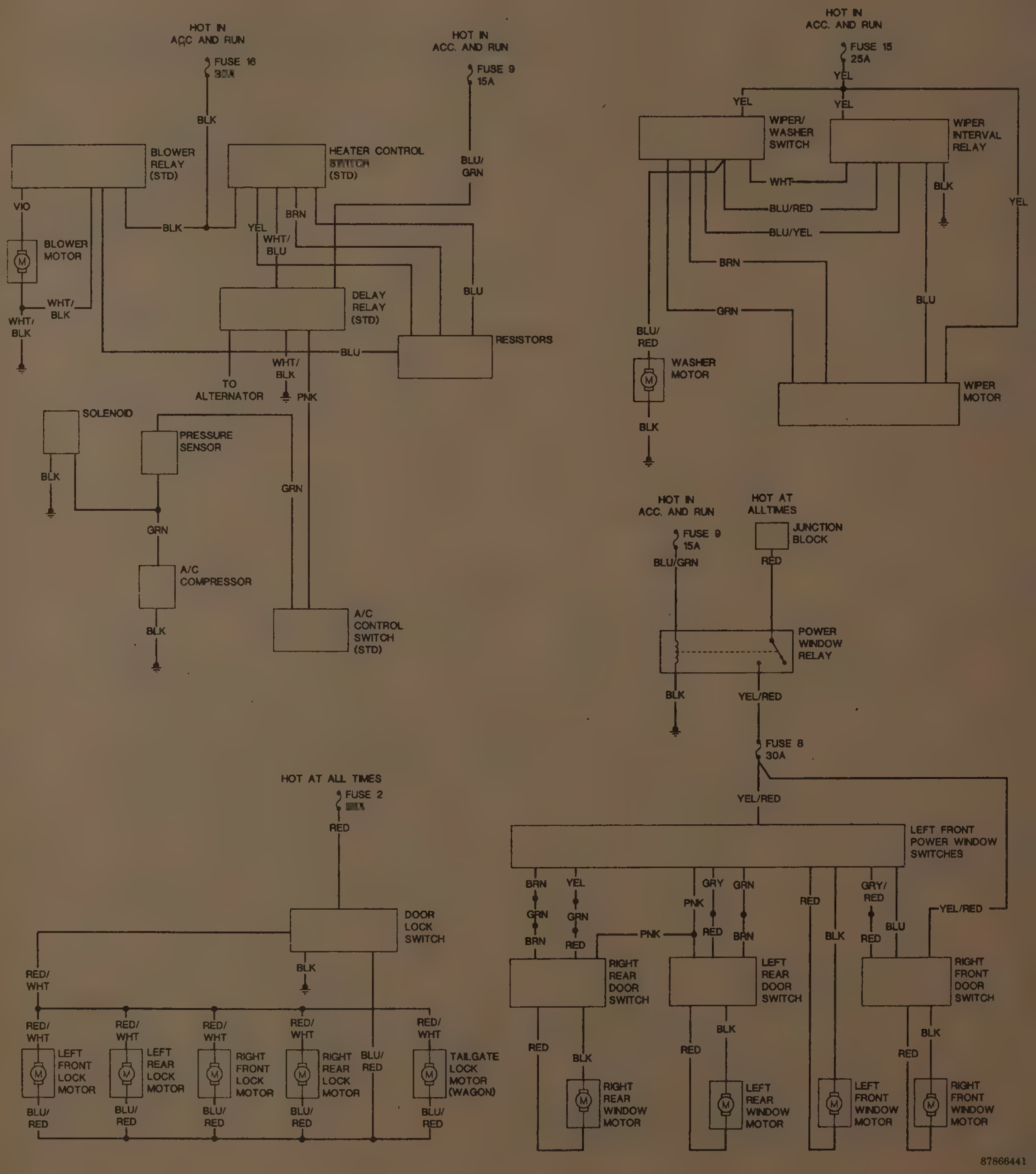

HOT IN ACC. AND RUN
FUSE 16
BLK
BLOWER RELAY (STD)
VIO
BLOWER MOTOR
WHT/ BLK
WHT/ BLK
HEATER CONTROL SWITCH (STD)
HOT IN ACC. AND RUN
FUSE 9 15A
BLU/ GRN
BRN
YEL
WHT/ BLU
DELAY RELAY (STD)
BLU
RESISTORS
WHT/ BLK
TO ALTERNATOR
PNK
SOLENOID
PRESSURE SENSOR
BLK
GRN
GRN
A/C COMPRESSOR
BLK
A/C CONTROL SWITCH (STD)
HOT IN ACC. AND RUN
FUSE 15 25A
YEL
YEL
YEL
WIPER/ WASHER SWITCH
WIPER INTERVAL RELAY
WHT
BLK
BLU/RED
BLU/YEL
BRN
GRN
BLU
YEL
BLU/ RED
WASHER MOTOR
BLK
WIPER MOTOR
HOT IN ACC. AND RUN
FUSE 9 15A
BLU/GRN
HOT AT ALLTIMES
JUNCTION BLOCK
RED
POWER WINDOW RELAY
BLK
YEL/RED
FUSE 8 30A
YEL/RED
LEFT FRONT POWER WINDOW SWITCHES
BRN
YEL
GRN
GRN
BRN
RED
GRY
GRN
PNK
PNK
RED
BRN
RED
GRY/ RED
RED
BLU
BLK
YEL/RED
RIGHT REAR DOOR SWITCH
LEFT REAR DOOR SWITCH
RIGHT FRONT DOOR SWITCH
RED
BLK
RED
BLK
BLK
RED
RIGHT REAR WINDOW MOTOR
LEFT REAR WINDOW MOTOR
LEFT FRONT WINDOW MOTOR
RIGHT FRONT WINDOW MOTOR
HOT AT ALL TIMES
FUSE 2
RED
DOOR LOCK SWITCH
BLK
RED/ WHT
RED/ WHT
RED/ WHT
RED/ WHT
RED/ WHT
RED/ WHT
LEFT FRONT LOCK MOTOR
LEFT REAR LOCK MOTOR
RIGHT FRONT LOCK MOTOR
RIGHT REAR LOCK MOTOR
BLU/ RED
TAILGATE LOCK MOTOR (WAGON)
BLU/ RED
BLU/ RED
BLU/ RED
BLU/ RED
BLU/ RED
87866441

Fig. 126 Chassis wiring — 1987 740 and 760 GL/GLE sedan and wagon

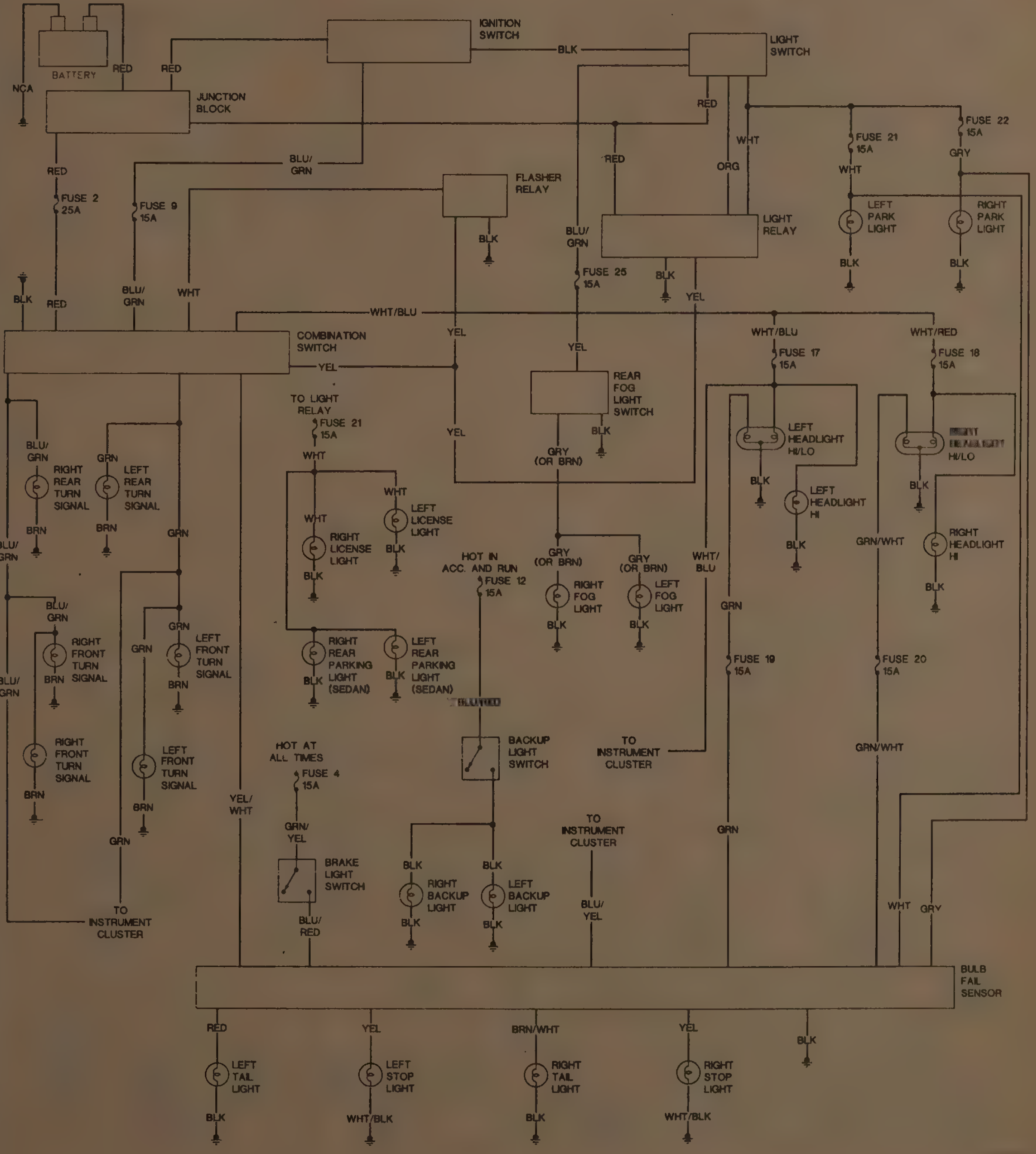

BATTERY
NCA
RED
RED
JUNCTION BLOCK
IGNITION SWITCH
BLK
LIGHT SWITCH
RED
WHT
ORG
RED
FUSE 21 15A
WHT
FUSE 22 15A
GRY
BLU/ GRN
RED
FUSE 2 25A
FUSE 9 15A
FLASHER RELAY
BLK
BLU/ GRN
LIGHT RELAY
LEFT PARK LIGHT
RIGHT PARK LIGHT
BLK
BLK
FUSE 25 15A
BLK
YEL
BLK
RED
BLU/ GRN
WHT
WHT/BLU
COMBINATION SWITCH
YEL
YEL
YEL
WHT/BLU
WHT/RED
FUSE 17 15A
FUSE 18 15A
REAR FOG LIGHT SWITCH
TO LIGHT RELAY
FUSE 21 15A
YEL
BLK
GRY (OR BRN)
LEFT HEADLIGHT HI/LO
RIGHT HEADLIGHT HI/LO
WHT
BLU/ GRN
GRN
RIGHT REAR TURN SIGNAL
LEFT REAR TURN SIGNAL
WHT
LEFT LICENSE LIGHT
BLK
BLK
LEFT HEADLIGHT HI
WHT
RIGHT LICENSE LIGHT
BLK
BRN
BRN
GRN
HOT IN ACC. AND RUN
GRY (OR BRN)
GRY (OR BRN)
WHT/ BLU
BLK
GRN/WHT
RIGHT HEADLIGHT HI
BLU/ GRN
BLK
FUSE 12 15A
RIGHT FOG LIGHT
LEFT FOG LIGHT
BLU/ GRN
BLK
BLK
GRN
BLK
RIGHT FRONT TURN SIGNAL
GRN
GRN
LEFT FRONT TURN SIGNAL
RIGHT REAR PARKING LIGHT (SEDAN)
LEFT REAR PARKING LIGHT (SEDAN)
BLK
BLK
FUSE 19 15A
FUSE 20 15A
BRN
BRN
BLU/ GRN
BLU/RED
BACKUP LIGHT SWITCH
TO INSTRUMENT CLUSTER
GRN/WHT
RIGHT FRONT TURN SIGNAL
HOT AT ALL TIMES
FUSE 4 15A
LEFT FRONT TURN SIGNAL
BRN
YEL/ WHT
BRN
GRN/ YEL
TO INSTRUMENT CLUSTER
GRN
GRN
BRAKE LIGHT SWITCH
BLK
BLK
RIGHT BACKUP LIGHT
LEFT BACKUP LIGHT
BLK
BLK
BLU/ YEL
WHT
GRY
TO INSTRUMENT CLUSTER
BLU/ RED
BULB FAIL SENSOR
RED
YEL
BRN/WHT
YEL
BLK
LEFT TAIL LIGHT
LEFT STOP LIGHT
RIGHT TAIL LIGHT
RIGHT STOP LIGHT
BLK
WHT/BLK
BLK
WHT/BLK

Fig. 127 Chassis wiring — 1987 740 and 760 GL/GLE sedan and wagon (continued)

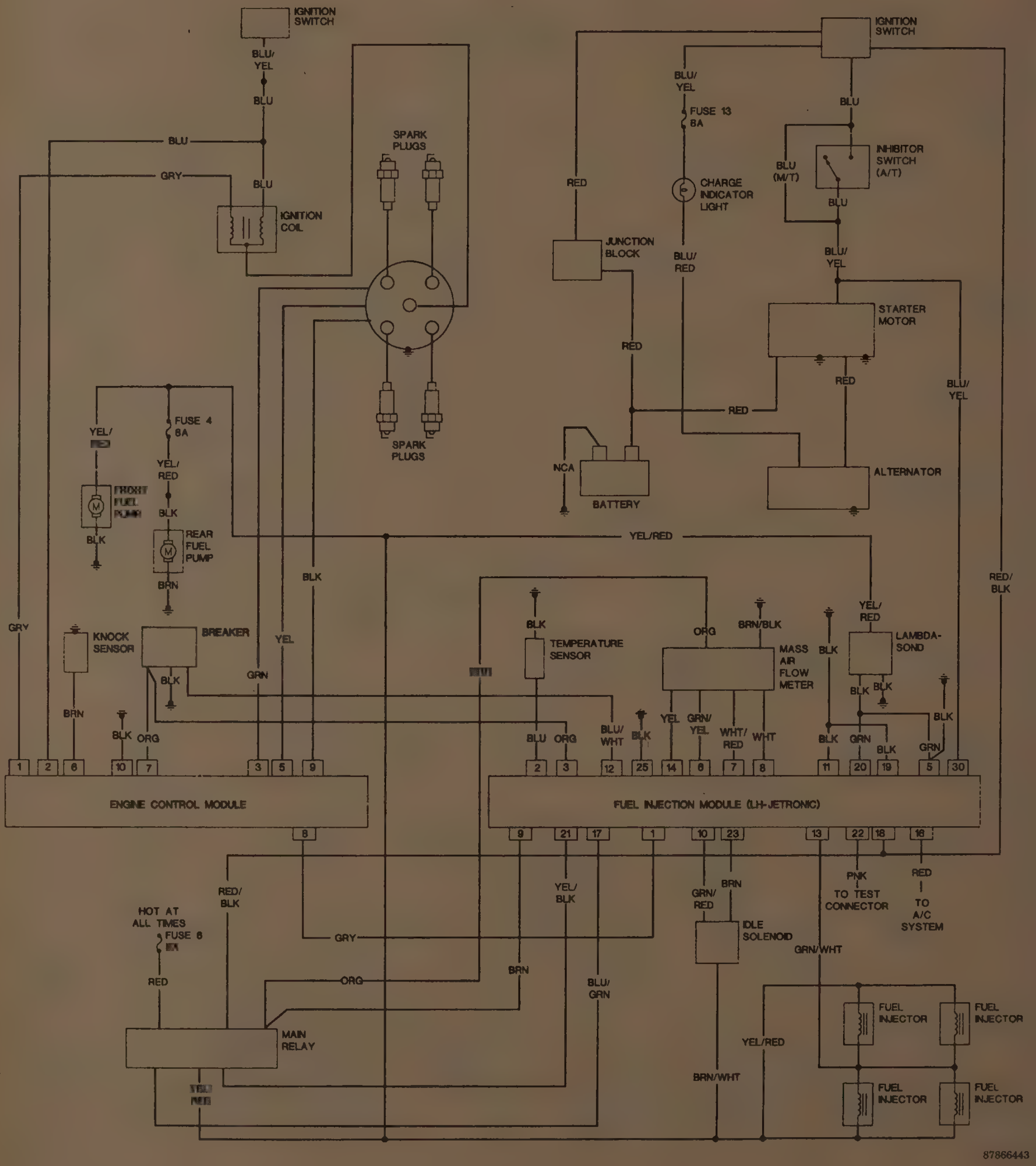

IGNITION SWITCH
BLU/ YEL
BLU
BLU
GRY
BLU
IGNITION COIL
SPARK PLUGS
SPARK PLUGS
YEL/ RED
FUSE 4 8A
YEL/ RED
FRONT FUEL PUMP
BLK
BLK
REAR FUEL PUMP
BRN
GRY
KNOCK SENSOR
BRN
BREAKER
BLK
BLK
ORG
YEL
GRN
BLK
1
2
6
10
7
3
5
9
ENGINE CONTROL MODULE
8
IGNITION SWITCH
BLU/ YEL
FUSE 13 8A
CHARGE INDICATOR LIGHT
BLU/ RED
RED
JUNCTION BLOCK
RED
RED
NCA
BATTERY
BLU
BLU (M/T)
INHIBITOR SWITCH (A/T)
BLU
BLU/ YEL
STARTER MOTOR
RED
ALTERNATOR
BLU/ YEL
RED/ BLK
YEL/RED
BLK
TEMPERATURE SENSOR
WHT
ORG
BRN/BLK
MASS AIR FLOW METER
BLK
YEL/ RED
LAMBDA-SOND
BLK
BLK
BLK
BLU
ORG
BLU/ WHT
BLK
YEL
GRN/ YEL
WHT/ RED
WHT
BLK
GRN
BLK
GRN
2
3
12
25
14
6
7
8
11
20
19
5
30
FUEL INJECTION MODULE (LH-JETRONIC)
9
21
17
1
10
23
13
22
18
16
RED/ BLK
YEL/ BLK
GRN/ RED
BRN
PNK
TO TEST CONNECTOR
RED
TO A/C SYSTEM
IDLE SOLENOID
GRN/WHT
HOT AT ALL TIMES
FUSE 6 8A
RED
GRY
ORG
BRN
BLU/ GRN
MAIN RELAY
YEL/ RED
YEL/RED
BRN/WHT
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
87866443

Fig. 128 Engine wiring — 1987 240 DL/GL sedan and wagon (2.3L)

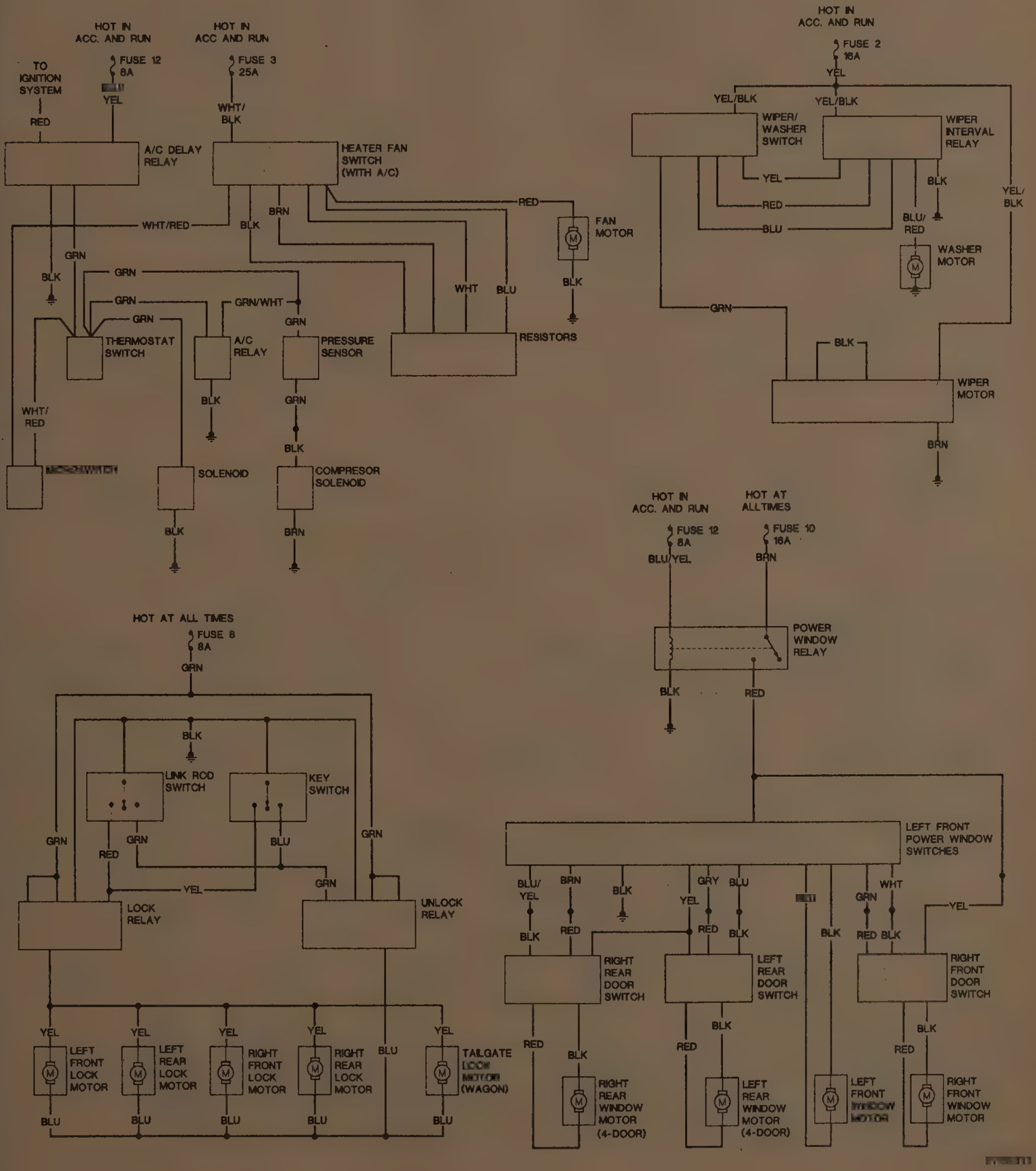

HOT IN ACC. AND RUN
FUSE 12 8A
YEL
TO IGNITION SYSTEM
RED
HOT IN ACC AND RUN
FUSE 3 25A
WHT/BLK
A/C DELAY RELAY
HEATER FAN SWITCH (WITH A/C)
WHT/RED
BRN
BLK
RED
FAN MOTOR
GRN
BLK
GRN
GRN
GRN/WHT
GRN
THERMOSTAT SWITCH
A/C RELAY
PRESSURE SENSOR
WHT
BLU
RESISTORS
WHT/RED
BLK
GRN
BLK
SOLENOID
COMPRESOR SOLENOID
BLK
BRN
HOT IN ACC. AND RUN
FUSE 2 16A
YEL
YEL/BLK
YEL/BLK
WIPER/WASHER SWITCH
WIPER INTERVAL RELAY
YEL
RED
BLU
BLK
BLU/RED
WASHER MOTOR
YEL/BLK
GRN
BLK
WIPER MOTOR
BRN
HOT IN ACC. AND RUN
FUSE 12 8A
BLU/YEL
HOT AT ALLTIMES
FUSE 10 16A
BRN
POWER WINDOW RELAY
BLK
RED
HOT AT ALL TIMES
FUSE 8 8A
GRN
BLK
LINK ROD SWITCH
KEY SWITCH
GRN
GRN
RED
BLU
GRN
YEL
GRN
LOCK RELAY
UNLOCK RELAY
YEL
LEFT FRONT LOCK MOTOR
YEL
LEFT REAR LOCK MOTOR
YEL
RIGHT FRONT LOCK MOTOR
YEL
RIGHT REAR LOCK MOTOR
BLU
YEL
TAILGATE (WAGON)
BLU
BLU
BLU
BLU
BLU
LEFT FRONT POWER WINDOW SWITCHES
BLU/YEL
BRN
BLK
GRY
BLU
YEL
GRN
WHT
YEL
BLK
RED
RED
BLK
BLK
RED BLK
RIGHT REAR DOOR SWITCH
LEFT REAR DOOR SWITCH
RIGHT FRONT DOOR SWITCH
RED
BLK
RIGHT REAR WINDOW MOTOR (4-DOOR)
RED
BLK
LEFT REAR WINDOW MOTOR (4-DOOR)
LEFT FRONT
RED
BLK
RIGHT FRONT WINDOW MOTOR

Fig. 129 Chassis wiring — 1987 240 DL/GL sedan and wagon

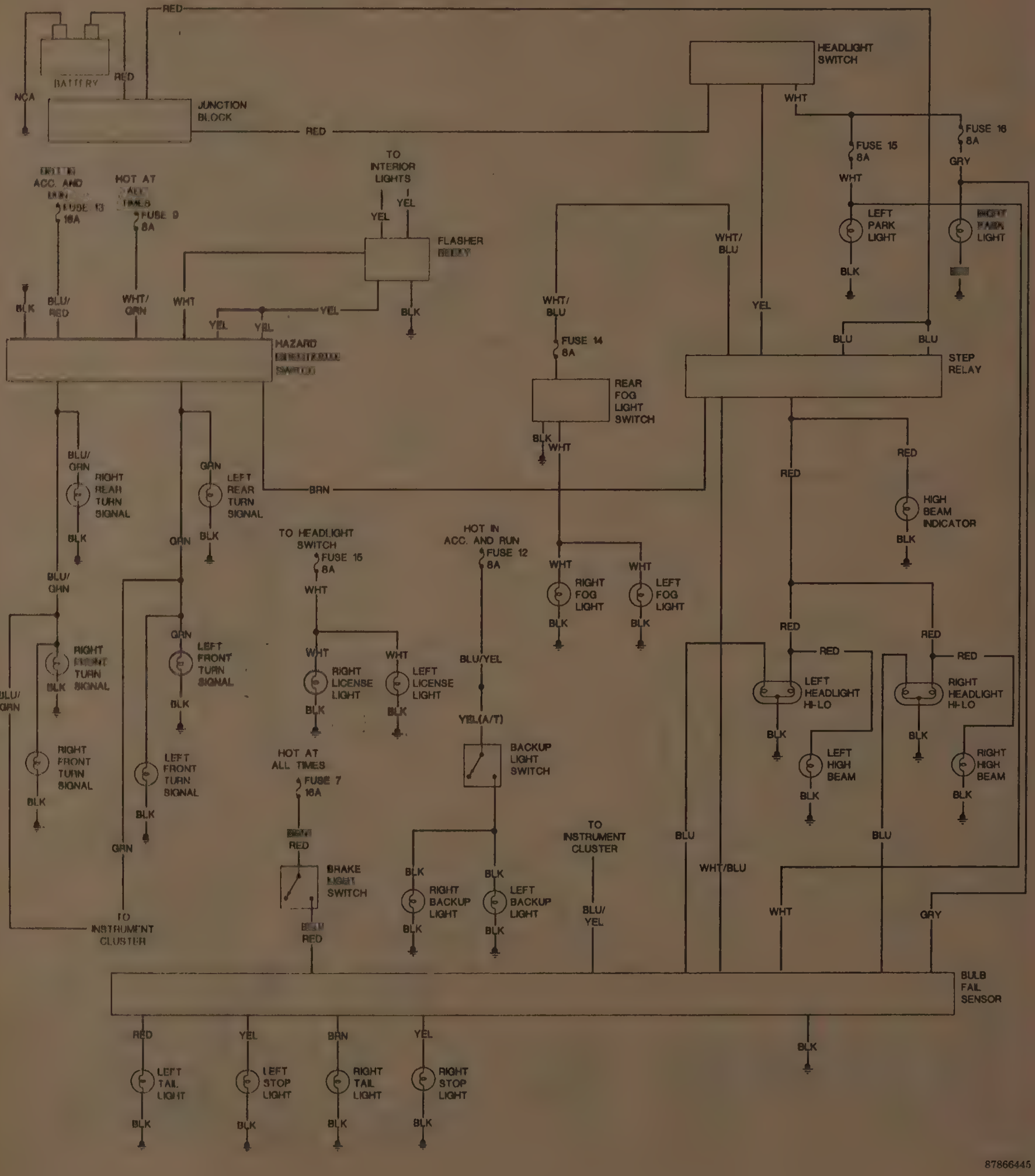

RED
BATTERY
RED
NCA
JUNCTION BLOCK
RED
HEADLIGHT SWITCH
WHT
FUSE 15 8A
FUSE 16 8A
GRY
WHT
LEFT PARK LIGHT
RIGHT PARK LIGHT
BLK
HOT IN ACC. AND RUN
FUSE 13 16A
HOT AT ALL TIMES
FUSE 9 8A
TO INTERIOR LIGHTS
YEL
YEL
FLASHER RELAY
BLK
BLU/RED
WHT/GRN
WHT
YEL
YEL
YEL
HAZARD WARNING SWITCH
WHT/BLU
WHT/BLU
FUSE 14 8A
YEL
BLU
BLU
STEP RELAY
REAR FOG LIGHT SWITCH
BLK
WHT
BLU/GRN
RIGHT REAR TURN SIGNAL
GRN
LEFT REAR TURN SIGNAL
BRN
RED
RED
HIGH BEAM INDICATOR
BLK
TO HEADLIGHT SWITCH
FUSE 15 8A
WHT
HOT IN ACC. AND RUN
FUSE 12 8A
WHT
WHT
RIGHT FOG LIGHT
LEFT FOG LIGHT
BLU/GRN
RIGHT FRONT TURN SIGNAL
GRN
LEFT FRONT TURN SIGNAL
RIGHT LICENSE LIGHT
LEFT LICENSE LIGHT
BLU/YEL
YEL(A/T)
RED
RED
RED
RED
LEFT HEADLIGHT HI-LO
RIGHT HEADLIGHT HI-LO
LEFT HIGH BEAM
RIGHT HIGH BEAM
BLU/GRN
RIGHT FRONT TURN SIGNAL
LEFT FRONT TURN SIGNAL
HOT AT ALL TIMES
FUSE 7 16A
RED
BACKUP LIGHT SWITCH
TO INSTRUMENT CLUSTER
BLU
BLU
WHT/BLU
GRN
BRAKE LIGHT SWITCH
RIGHT BACKUP LIGHT
LEFT BACKUP LIGHT
BLU/YEL
WHT
GRY
TO INSTRUMENT CLUSTER
RED
BULB FAIL SENSOR
RED
YEL
BRN
YEL
LEFT TAIL LIGHT
LEFT STOP LIGHT
RIGHT TAIL LIGHT
RIGHT STOP LIGHT
BLK
87866445

Fig. 130 Chassis wiring — 1987 240 DL/GL sedan and wagon (continued)

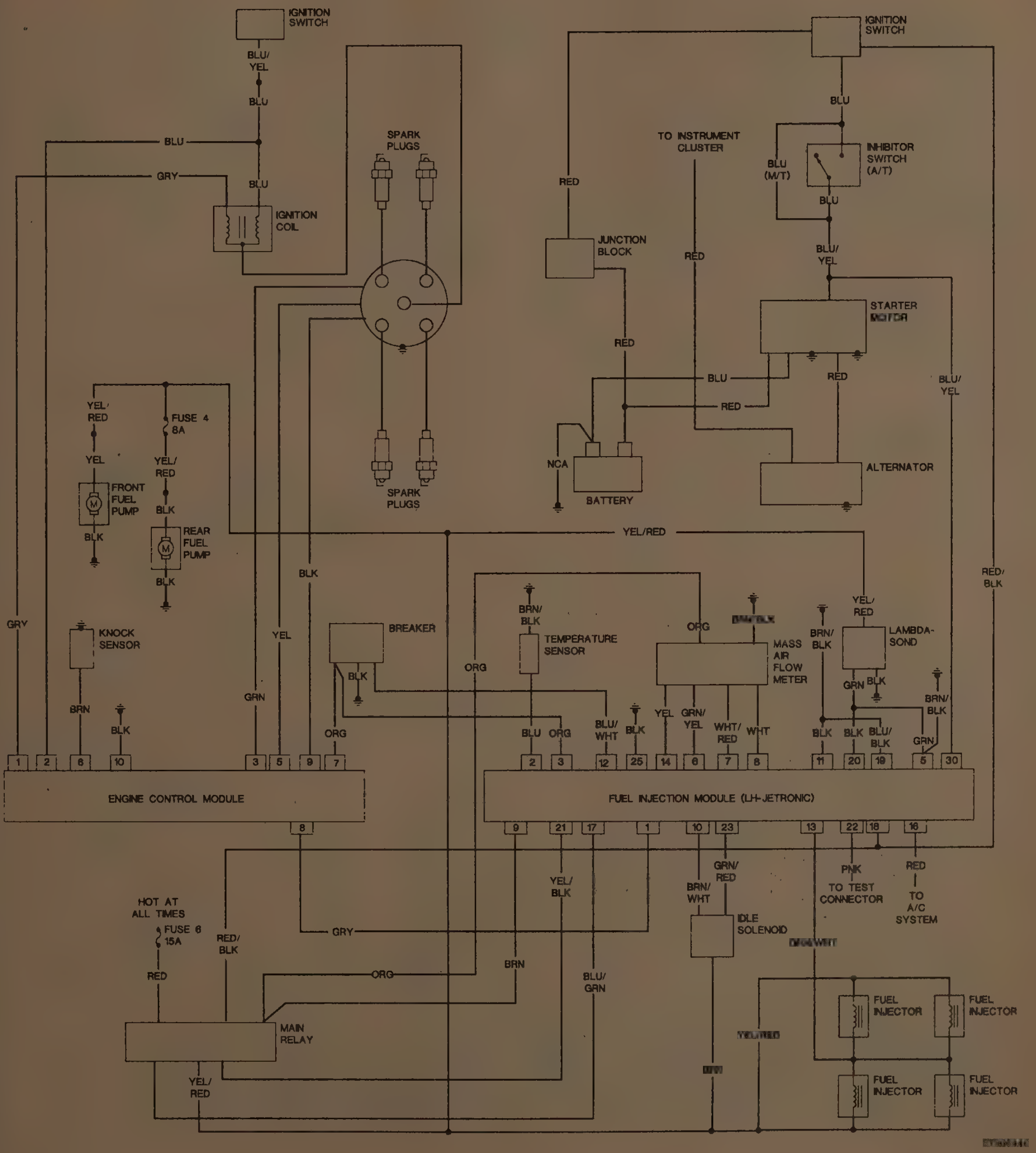
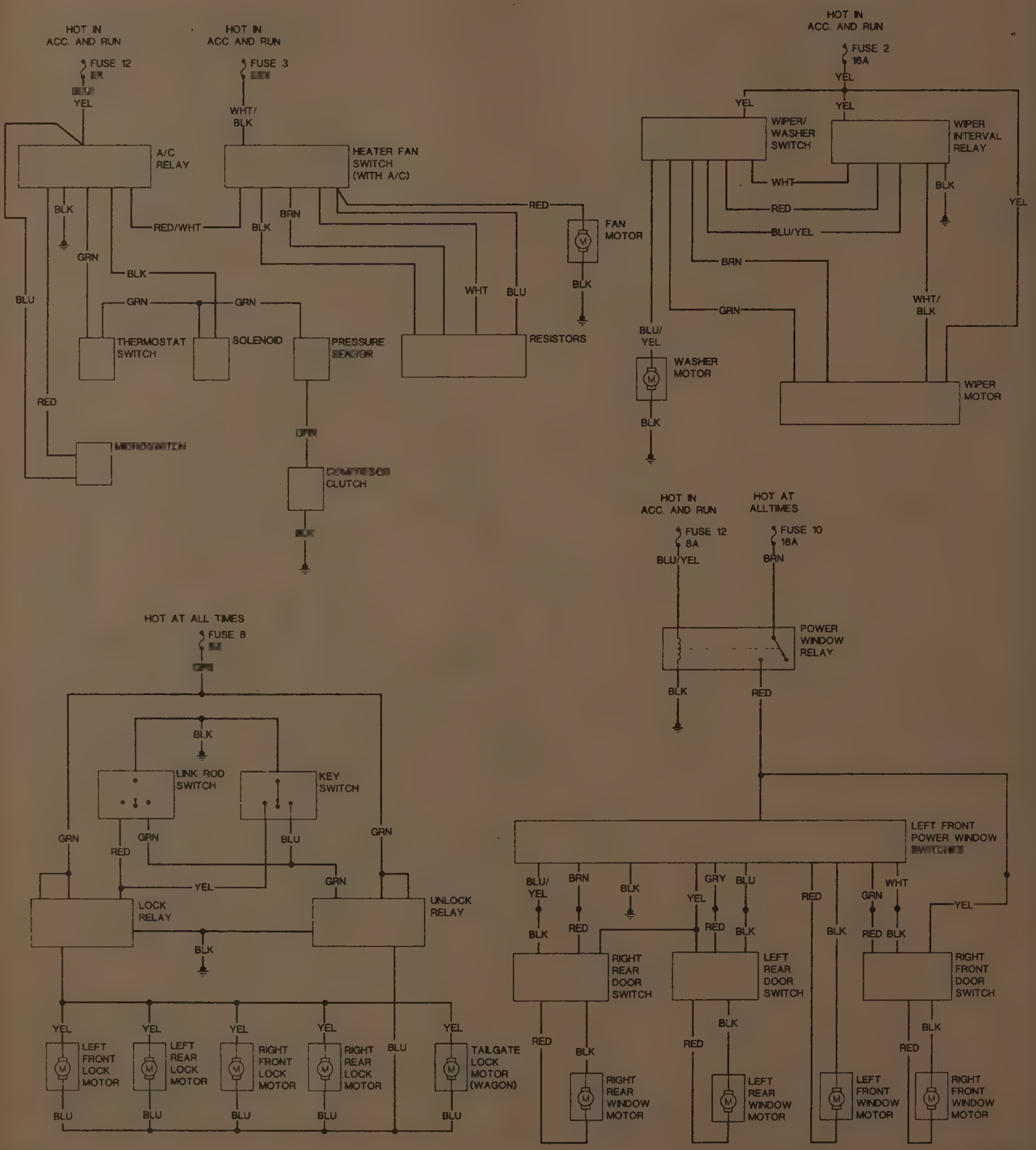

IGNITION SWITCH
BLU/ YEL
BLU
BLU
GRY
BLU
IGNITION COIL
SPARK PLUGS
SPARK PLUGS
YEL/ RED
FUSE 4 8A
YEL
YEL/ RED
FRONT FUEL PUMP
BLK
BLK
REAR FUEL PUMP
BLK
GRY
KNOCK SENSOR
BRN
BLK
YEL
GRN
BLK
BREAKER
BLK
ORG
ENGINE CONTROL MODULE
1
2
6
10
3
5
9
7
8
IGNITION SWITCH
TO INSTRUMENT CLUSTER
RED
BLU
BLU (M/T)
INHIBITOR SWITCH (A/T)
BLU
JUNCTION BLOCK
RED
BLU/ YEL
STARTER MOTOR
RED
BLU
RED
RED
BLU/ YEL
NCA
BATTERY
ALTERNATOR
YEL/RED
RED/ BLK
ORG
BRN/ BLK
TEMPERATURE SENSOR
ORG
MASS AIR FLOW METER
YEL/ RED
BRN/ BLK
LAMBDA-SOND
GRN
BLK
BRN/ BLK
BLU
ORG
BLU/ WHT
BLK
YEL
GRN/ YEL
WHT/ RED
WHT
BLK
BLK
BLU/ BLK
GRN
FUEL INJECTION MODULE (LH-JETRONIC)
2
3
12
25
14
6
7
8
11
20
19
5
30
9
21
17
1
10
23
13
22
18
16
YEL/ BLK
GRN/ RED
BRN/ WHT
PNK
TO TEST CONNECTOR
RED
TO A/C SYSTEM
IDLE SOLENOID
HOT AT ALL TIMES
FUSE 6 15A
RED/ BLK
RED
GRY
ORG
BRN
BLU/ GRN
MAIN RELAY
YEL/ RED
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR

Fig. 131 Engine wiring — 1988 240 DL/GL sedan and wagon (2.3L)


HOT IN ACC. AND RUN
FUSE 12
8A
BLU/YEL
A/C RELAY
BLK
GRN
RED/WHT
BLK
GRN
BLU
THERMOSTAT SWITCH
SOLENOID
PRESSURE SENSOR
RED
MICROSWITCH
ORN
COMPRESSOR CLUTCH
BLK
HOT IN ACC AND RUN
FUSE 3
16A
WHT/BLK
HEATER FAN SWITCH (WITH A/C)
BRN
BLK
RED
WHT
BLU
GRN
FAN MOTOR
BLK
RESISTORS
HOT IN ACC. AND RUN
FUSE 2
16A
YEL
YEL
YEL
WIPER/WASHER SWITCH
WIPER INTERVAL RELAY
WHT
RED
BLU/YEL
BLK
YEL
BRN
GRN
WHT/BLK
BLU/YEL
WASHER MOTOR
BLK
WIPER MOTOR
HOT IN ACC. AND RUN
FUSE 12
8A
BLU/YEL
HOT AT ALLTIMES
FUSE 10
16A
BRN
POWER WINDOW RELAY
BLK
RED
HOT AT ALL TIMES
FUSE 8
8A
ORN
BLK
LINK ROD SWITCH
KEY SWITCH
GRN
GRN
RED
BLU
GRN
YEL
GRN
LOCK RELAY
UNLOCK RELAY
BLK
YEL
LEFT FRONT LOCK MOTOR
YEL
LEFT REAR LOCK MOTOR
YEL
RIGHT FRONT LOCK MOTOR
YEL
RIGHT REAR LOCK MOTOR
BLU
YEL
TAILGATE LOCK MOTOR (WAGON)
BLU
BLU
BLU
BLU
BLU
LEFT FRONT POWER WINDOW SWITCHES
BLU/YEL
BRN
BLK
GRY
BLU
YEL
RED
GRN
WHT
YEL
BLK
RED
RED
BLK
BLK
RED
BLK
RIGHT REAR DOOR SWITCH
LEFT REAR DOOR SWITCH
RIGHT FRONT DOOR SWITCH
RED
BLK
RIGHT REAR WINDOW MOTOR
RED
BLK
LEFT REAR WINDOW MOTOR
LEFT FRONT WINDOW MOTOR
RED
BLK
RIGHT FRONT WINDOW MOTOR
M

87866447

Fig. 132 Chassis wiring — 1988 240 DL/GL sedan and wagon

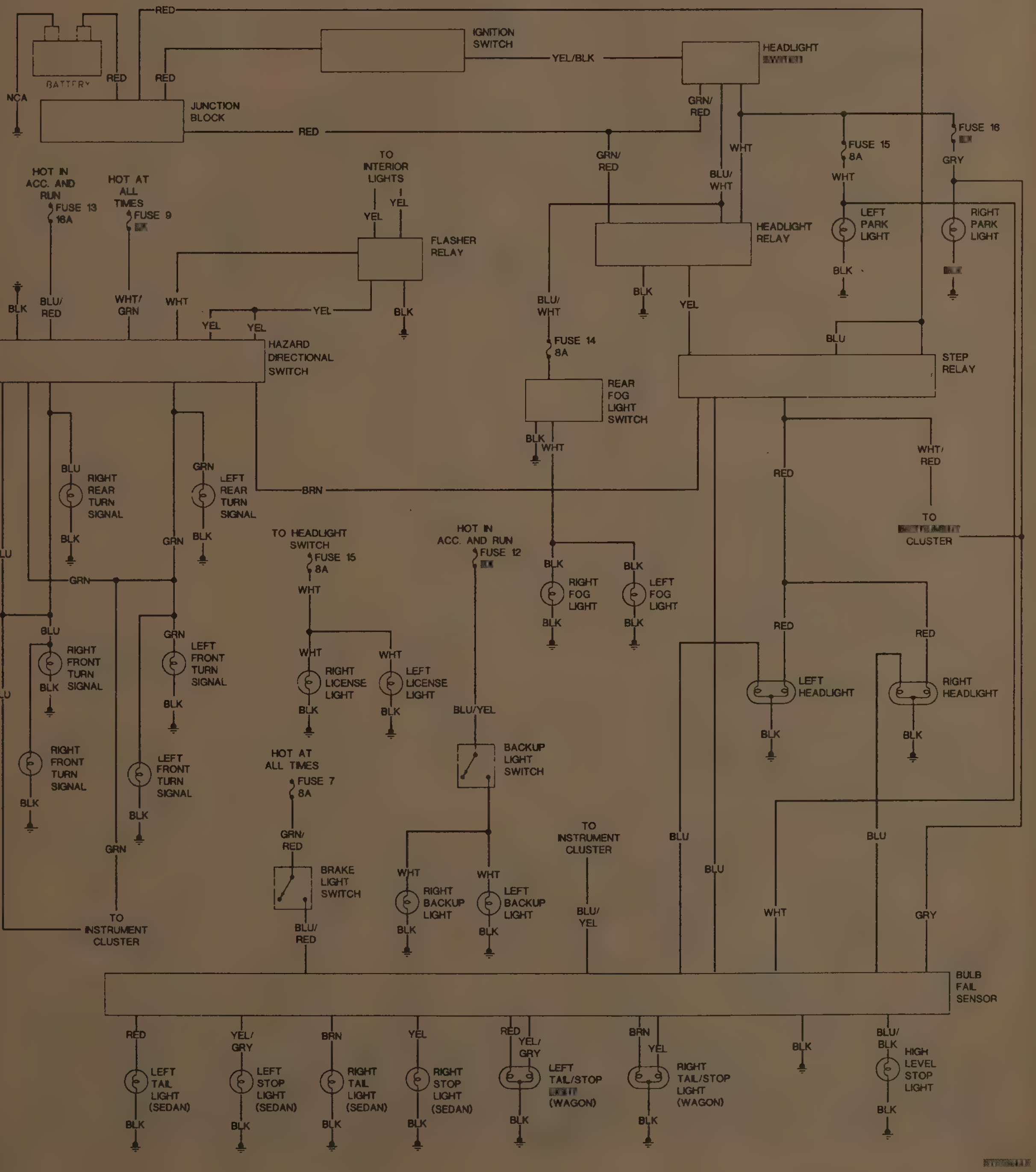

RED
BATTERY
RED
RED
NCA
JUNCTION BLOCK
IGNITION SWITCH
YEL/BLK
HEADLIGHT SWITCH
GRN/ RED
RED
WHT
FUSE 16
FUSE 15 8A
GRY
HOT IN ACC. AND RUN
FUSE 13 16A
HOT AT ALL TIMES
FUSE 9
TO INTERIOR LIGHTS
YEL
YEL
GRN/ RED
BLU/ WHT
WHT
LEFT PARK LIGHT
RIGHT PARK LIGHT
HEADLIGHT RELAY
FLASHER RELAY
BLK
BLK
BLK
BLU/ RED
WHT/ GRN
WHT
YEL
YEL
YEL
BLK
BLU/ WHT
BLK
YEL
BLU
HAZARD DIRECTIONAL SWITCH
FUSE 14 8A
STEP RELAY
REAR FOG LIGHT SWITCH
BLK
WHT
BLU
RIGHT REAR TURN SIGNAL
GRN
LEFT REAR TURN SIGNAL
BRN
RED
WHT/ RED
BLK
GRN
BLK
TO CLUSTER
BLU
TO HEADLIGHT SWITCH
FUSE 15 8A
HOT IN ACC. AND RUN
FUSE 12
BLK
BLK
GRN
WHT
RIGHT FOG LIGHT
LEFT FOG LIGHT
BLK
BLK
BLU
GRN
RED
RED
RIGHT FRONT TURN SIGNAL
LEFT FRONT TURN SIGNAL
WHT
WHT
BLK
RIGHT LICENSE LIGHT
LEFT LICENSE LIGHT
LEFT HEADLIGHT
RIGHT HEADLIGHT
BLU
BLK
BLK
BLK
BLU/YEL
BLK
BLK
RIGHT FRONT TURN SIGNAL
LEFT FRONT TURN SIGNAL
HOT AT ALL TIMES
BACKUP LIGHT SWITCH
BLK
FUSE 7 8A
BLK
GRN/ RED
TO INSTRUMENT CLUSTER
BLU
BLU
GRN
BRAKE LIGHT SWITCH
BLU
WHT
WHT
RIGHT BACKUP LIGHT
LEFT BACKUP LIGHT
BLU/ YEL
WHT
GRY
TO INSTRUMENT CLUSTER
BLU/ RED
BLK
BLK
BULB FAIL SENSOR
RED
YEL/ GRY
BRN
YEL
RED
YEL/ GRY
BRN
YEL
BLK
BLU/ BLK
LEFT TAIL LIGHT (SEDAN)
LEFT STOP LIGHT (SEDAN)
RIGHT TAIL LIGHT (SEDAN)
RIGHT STOP LIGHT (SEDAN)
LEFT TAIL/STOP LIGHT (WAGON)
RIGHT TAIL/STOP LIGHT (WAGON)
HIGH LEVEL STOP LIGHT
BLK
BLK
BLK
BLK
BLK
BLK
BLK

Fig. 133 Chassis wiring — 1988 240 DL/GL sedan and wagon (continued)

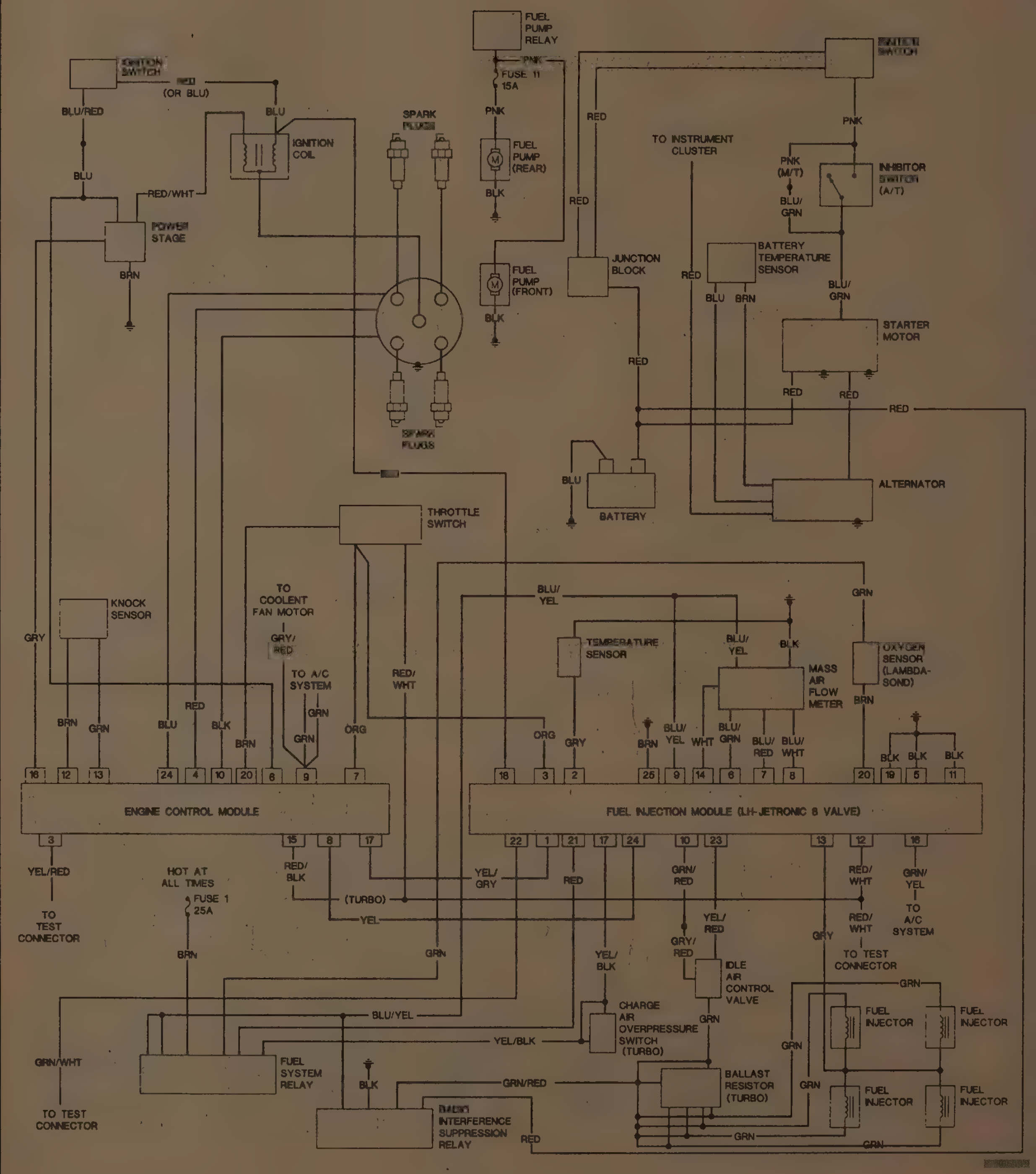

FUEL PUMP RELAY
IGNITION SWITCH
IGNITION SWITCH
RED
(OR BLU)
PNK
FUSE 11 15A
BLU/RED
BLU
SPARK PLUGS
IGNITION COIL
PNK
FUEL PUMP (REAR)
RED
PNK
TO INSTRUMENT CLUSTER
BLU
RED/WHT
POWER STAGE
BRN
BLK
RED
PNK (M/T)
BLU/GRN
INHIBITOR SWITCH (A/T)
FUEL PUMP (FRONT)
BLK
JUNCTION BLOCK
RED
BATTERY TEMPERATURE SENSOR
BLU
BRN
BLU/GRN
STARTER MOTOR
RED
RED
RED
RED
SPARK PLUGS
BLU
BATTERY
ALTERNATOR
THROTTLE SWITCH
KNOCK SENSOR
TO COOLENT FAN MOTOR
GRY/RED
TO A/C SYSTEM
RED/WHT
BLU/YEL
GRN
TEMPERATURE SENSOR
BLU/YEL
BLK
OXYGEN SENSOR (LAMBDA-SOND)
MASS AIR FLOW METER
GRY
RED
BRN
GRN
BLU
BLK
BRN
GRN
GRN
ORG
ORG
GRY
BRN
BLU/YEL
WHT
BLU/GRN
BLU/RED
BLU/WHT
BRN
BLK
BLK
BLK
16
12
13
24
4
10
20
6
9
7
18
3
2
25
9
14
6
7
8
20
19
5
11
ENGINE CONTROL MODULE
FUEL INJECTION MODULE (LH-JETRONIC 8 VALVE)
3
15
8
17
22
1
21
17
24
10
23
13
12
16
YEL/RED
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 1 25A
RED/BLK
(TURBO)
YEL
YEL/GRY
RED
GRN/RED
YEL/RED
GRY/RED
RED/WHT
RED/WHT
GRN/YEL
TO A/C SYSTEM
GRY
TO TEST CONNECTOR
BRN
GRN
YEL/BLK
IDLE AIR CONTROL VALVE
GRN
BLU/YEL
CHARGE AIR OVERPRESSURE SWITCH (TURBO)
GRN
FUEL INJECTOR
FUEL INJECTOR
YEL/BLK
GRN/WHT
GRN
FUEL SYSTEM RELAY
BLK
GRN/RED
BALLAST RESISTOR (TURBO)
GRN
FUEL INJECTOR
FUEL INJECTOR
TO TEST CONNECTOR
RADIO INTERFERENCE SUPPRESSION RELAY
RED
GRN
GRN

Fig. 134 Engine wiring — 1988 740 GL/GLE sedan and Wagon (2.3L LH-Jetronic turbo and normally aspirated)

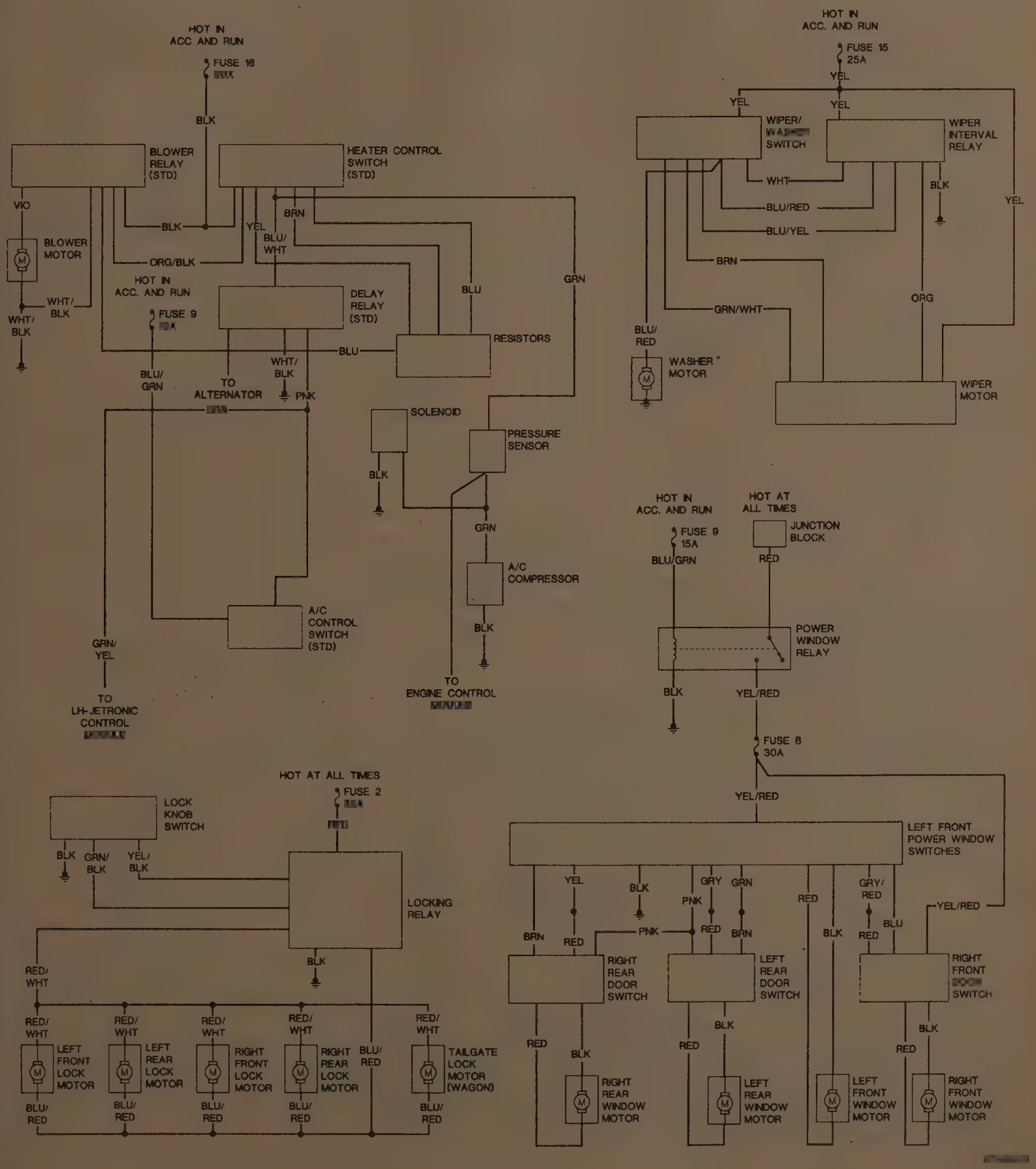

HOT IN ACC. AND RUN
FUSE 18
BLK
BLOWER RELAY (STD)
HEATER CONTROL SWITCH (STD)
VIO
BLOWER MOTOR
WHT/ BLK
WHT/ BLK
BLK
ORG/BLK
YEL
BRN
BLU/ WHT
HOT IN ACC. AND RUN
FUSE 9
DELAY RELAY (STD)
BLU
GRN
BLU
RESISTORS
WHT/ BLK
BLU/ GRN
TO ALTERNATOR
PNK
SOLENOID
PRESSURE SENSOR
BLK
GRN
A/C COMPRESSOR
BLK
A/C CONTROL SWITCH (STD)
GRN/ YEL
TO LH-JETRONIC CONTROL
TO ENGINE CONTROL
HOT IN ACC. AND RUN
FUSE 15 25A
YEL
YEL
YEL
WIPER/ SWITCH
WIPER INTERVAL RELAY
WHT
BLK
BLU/RED
BLU/YEL
YEL
BRN
ORG
GRN/WHT
BLU/ RED
WASHER MOTOR
WIPER MOTOR
HOT IN ACC. AND RUN
HOT AT ALL TIMES
FUSE 9 15A
JUNCTION BLOCK
BLU/GRN
RED
POWER WINDOW RELAY
BLK
YEL/RED
FUSE 8 30A
YEL/RED
LEFT FRONT POWER WINDOW SWITCHES
YEL
BLK
GRY
GRN
PNK
RED
GRY/ RED
YEL/RED
BLU
BRN
RED
PNK
RED
BRN
BLK
RED
RIGHT REAR DOOR SWITCH
LEFT REAR DOOR SWITCH
RIGHT FRONT SWITCH
RED
BLK
BLK
RED
BLK
RED
RIGHT REAR WINDOW MOTOR
LEFT REAR WINDOW MOTOR
LEFT FRONT WINDOW MOTOR
RIGHT FRONT WINDOW MOTOR
HOT AT ALL TIMES
FUSE 2
LOCK KNOB SWITCH
BLK
GRN/ BLK
YEL/ BLK
LOCKING RELAY
BLK
RED/ WHT
RED/ WHT
RED/ WHT
RED/ WHT
RED/ WHT
RED/ WHT
LEFT FRONT LOCK MOTOR
LEFT REAR LOCK MOTOR
RIGHT FRONT LOCK MOTOR
RIGHT REAR LOCK MOTOR
BLU/ RED
TAILGATE LOCK MOTOR (WAGON)
BLU/ RED
BLU/ RED
BLU/ RED
BLU/ RED
BLU/ RED
M

Fig. 135 Chassis wiring — 1988 240 GL/GLE sedan and wagon

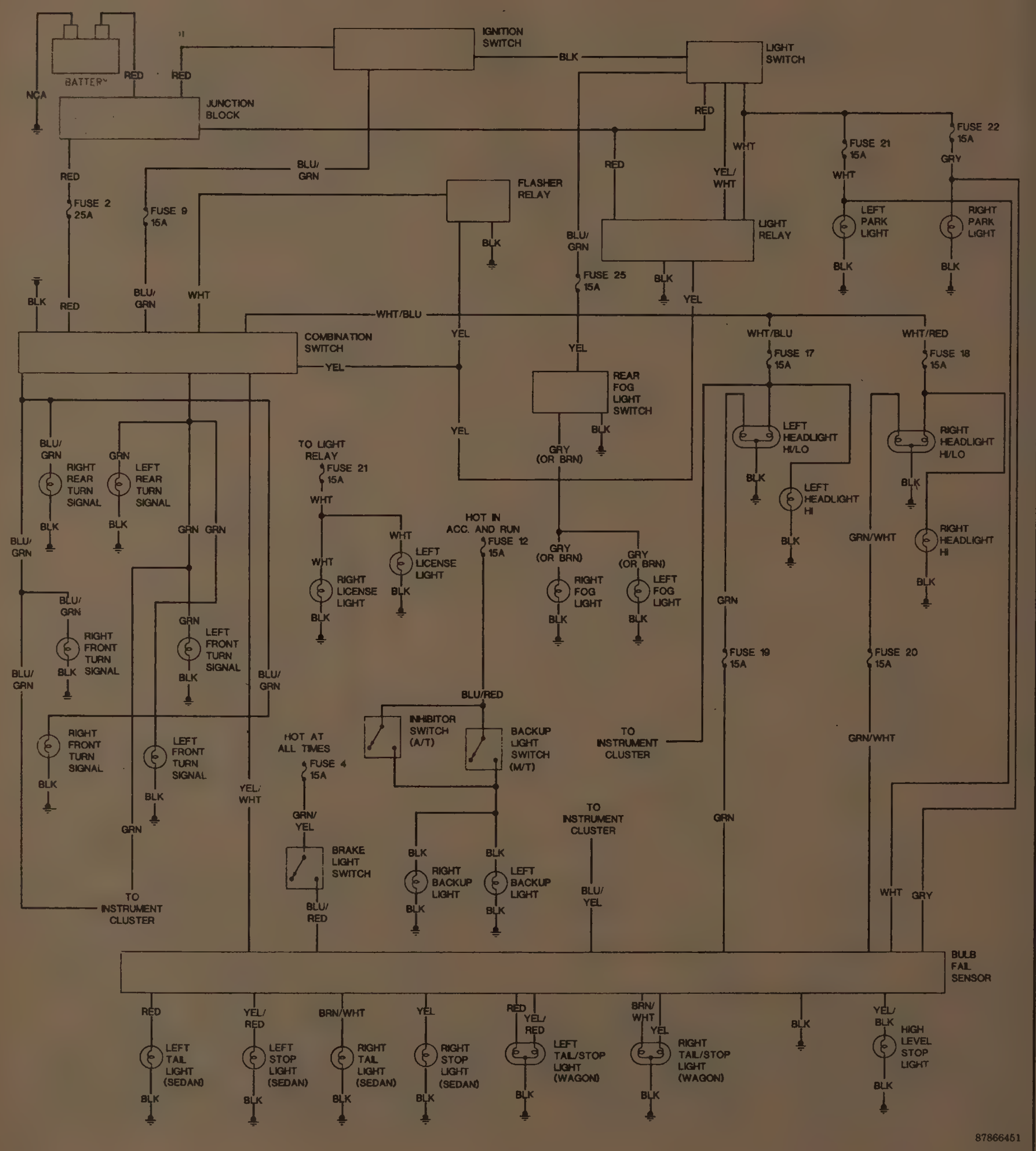

IGNITION SWITCH
BLK
LIGHT SWITCH
BATTERY
NCA
RED
RED
JUNCTION BLOCK
RED
WHT
FUSE 22 15A
GRY
FUSE 21 15A
WHT
RED
YEL/ WHT
BLU/ GRN
RED
FUSE 2 25A
FUSE 9 15A
FLASHER RELAY
BLK
BLU/ GRN
LIGHT RELAY
LEFT PARK LIGHT
RIGHT PARK LIGHT
FUSE 25 15A
BLK
YEL
BLK
BLK
BLK
RED
BLU/ GRN
WHT
WHT/BLU
COMBINATION SWITCH
YEL
YEL
WHT/BLU
WHT/RED
FUSE 17 15A
FUSE 18 15A
REAR FOG LIGHT SWITCH
BLK
GRY (OR BRN)
YEL
LEFT HEADLIGHT HI/LO
RIGHT HEADLIGHT HI/LO
BLK
BLK
LEFT HEADLIGHT HI
RIGHT HEADLIGHT HI
BLK
BLK
GRN/WHT
BLU/ GRN
RIGHT REAR TURN SIGNAL
GRN
LEFT REAR TURN SIGNAL
BLK
BLK
GRN GRN
BLU/ GRN
TO LIGHT RELAY
FUSE 21 15A
WHT
WHT
WHT
LEFT LICENSE LIGHT
RIGHT LICENSE LIGHT
BLK
BLK
HOT IN ACC. AND RUN
FUSE 12 15A
GRY (OR BRN)
GRY (OR BRN)
RIGHT FOG LIGHT
LEFT FOG LIGHT
BLK
BLK
GRN
BLU/ GRN
RIGHT FRONT TURN SIGNAL
BLK
GRN
LEFT FRONT TURN SIGNAL
BLK
BLU/ GRN
BLU/ GRN
FUSE 19 15A
FUSE 20 15A
BLU/RED
INHIBITOR SWITCH (A/T)
BACKUP LIGHT SWITCH (M/T)
TO INSTRUMENT CLUSTER
GRN/WHT
RIGHT FRONT TURN SIGNAL
BLK
LEFT FRONT TURN SIGNAL
BLK
HOT AT ALL TIMES
FUSE 4 15A
YEL/ WHT
GRN/ YEL
GRN
BRAKE LIGHT SWITCH
BLK
BLK
RIGHT BACKUP LIGHT
LEFT BACKUP LIGHT
BLK
BLK
TO INSTRUMENT CLUSTER
GRN
GRN
TO INSTRUMENT CLUSTER
BLU/ RED
BLU/ YEL
WHT
GRY
BULB FAIL SENSOR
RED
YEL/ RED
BRN/WHT
YEL
RED
YEL/ RED
BRN/ WHT
YEL
BLK
YEL/ BLK
LEFT TAIL LIGHT (SEDAN)
LEFT STOP LIGHT (SEDAN)
RIGHT TAIL LIGHT (SEDAN)
RIGHT STOP LIGHT (SEDAN)
LEFT TAIL/STOP LIGHT (WAGON)
RIGHT TAIL/STOP LIGHT (WAGON)
HIGH LEVEL STOP LIGHT
BLK
BLK
BLK
BLK
BLK
BLK
BLK
87866451

Fig. 136 Chassis wiring — 1988 240 GL/GLE sedan and wagon (continued)

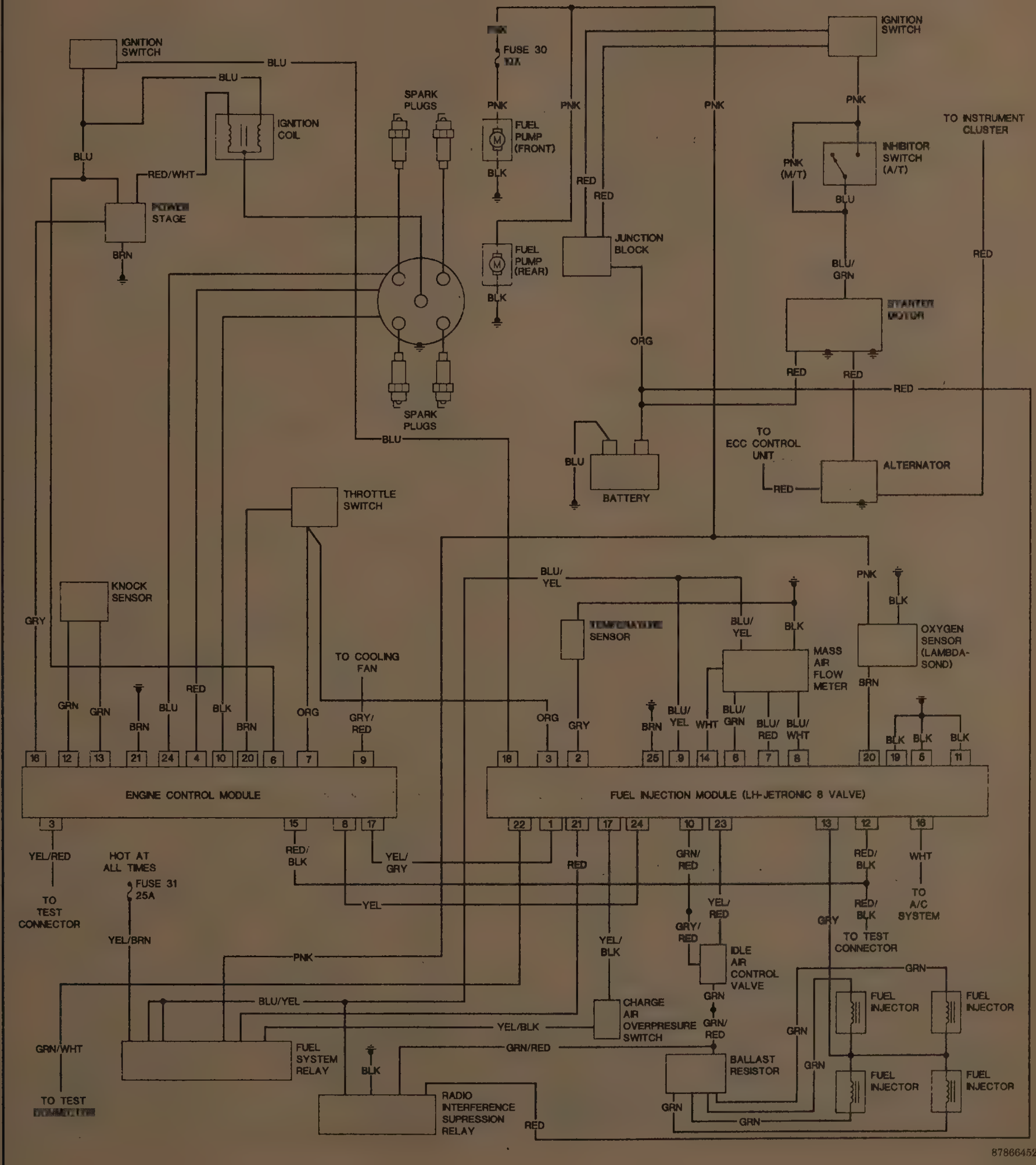

IGNITION SWITCH
BLU
BLU
IGNITION COIL
RED/WHT
POWER STAGE
BRN
SPARK PLUGS
SPARK PLUGS
PNK
FUSE 30 10A
PNK
FUEL PUMP (FRONT)
BLK
FUEL PUMP (REAR)
BLK
PNK
PNK
IGNITION SWITCH
PNK
TO INSTRUMENT CLUSTER
INHIBITOR SWITCH (A/T)
PNK (M/T)
BLU
RED
RED
JUNCTION BLOCK
ORG
BLU/ GRN
STARTER MOTOR
RED
RED
RED
RED
TO ECC CONTROL UNIT
RED
ALTERNATOR
BLU
BATTERY
BLU
THROTTLE SWITCH
KNOCK SENSOR
GRY
TO COOLING FAN
BLU/ YEL
TEMPERATURE SENSOR
BLU/ YEL
BLK
MASS AIR FLOW METER
PNK
BLK
OXYGEN SENSOR (LAMBDA-SOND)
BRN
GRN
GRN
BRN
RED
BLU
BLK
BRN
ORG
GRY/ RED
ORG
GRY
BRN
BLU/ YEL
WHT
BLU/ GRN
BLU/ RED
BLU/ WHT
BLK
BLK
BLK
16
12
13
21
24
4
10
20
6
7
9
18
3
2
25
9
14
6
7
8
20
19
5
11
ENGINE CONTROL MODULE
FUEL INJECTION MODULE (LH-JETRONIC 8 VALVE)
3
15
8
17
22
1
21
17
24
10
23
13
12
16
YEL/RED
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 31 25A
YEL/BRN
RED/ BLK
YEL/ GRY
YEL
RED
GRN/ RED
YEL/ RED
GRY/ RED
RED/ BLK
WHT
TO A/C SYSTEM
RED/ BLK
GRY
TO TEST CONNECTOR
YEL/ BLK
IDLE AIR CONTROL VALVE
PNK
BLU/YEL
GRN/WHT
TO TEST CONNECTOR
FUEL SYSTEM RELAY
BLK
YEL/BLK
CHARGE AIR OVERPRESURE SWITCH
GRN
GRN/ RED
GRN/RED
BALLAST RESISTOR
RADIO INTERFERENCE SUPRESSION RELAY
RED
GRN
GRN
GRN
GRN
GRN
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
87866452

Fig. 137 Engine wiring — 1988 760 sedan and wagon; 780 coupe (2.3L LH-Jetronic turbo)

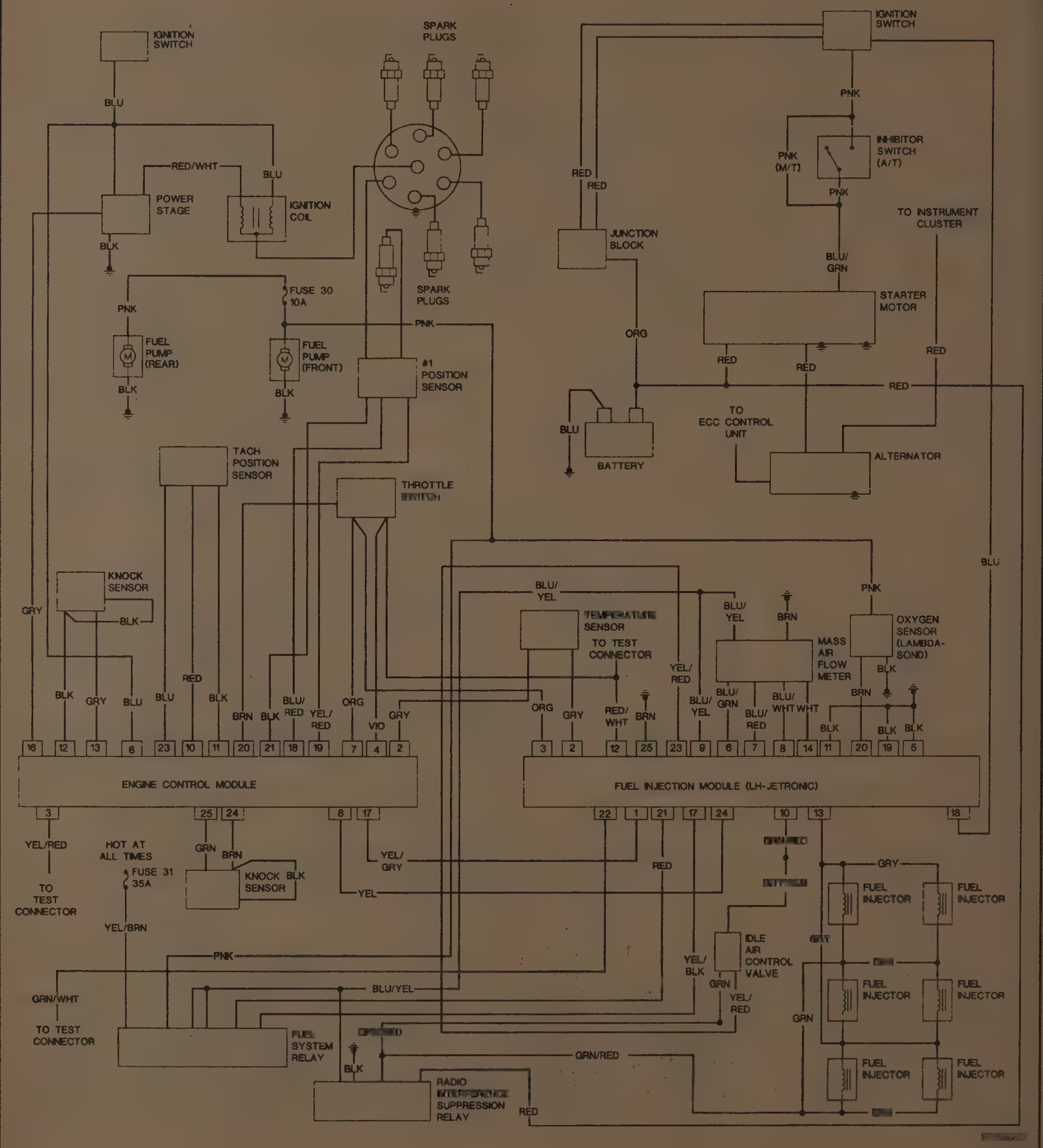

IGNITION SWITCH
BLU
RED/WHT
BLU
POWER STAGE
IGNITION COIL
BLK
SPARK PLUGS
SPARK PLUGS
PNK
FUSE 30 10A
FUEL PUMP (REAR)
FUEL PUMP (FRONT)
BLK
BLK
PNK
#1 POSITION SENSOR
TACH POSITION SENSOR
THROTTLE SWITCH
KNOCK SENSOR
BLK
GRY
BLK
GRY
BLU
BLU
RED
BLK
BRN
BLK
BLU/RED
YEL/RED
ORG
VIO
GRY
16
12
13
6
23
10
11
20
21
18
19
7
4
2
ENGINE CONTROL MODULE
3
25
24
8
17
YEL/RED
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 31 35A
GRN
BRN
KNOCK SENSOR
BLK
YEL/GRY
YEL
YEL/BRN
PNK
GRN/WHT
TO TEST CONNECTOR
BLU/YEL
FUEL SYSTEM RELAY
BLK
RADIO INTERFERENCE SUPPRESSION RELAY
RED
GRN/RED
IGNITION SWITCH
PNK
PNK (M/T)
INHIBITOR SWITCH (A/T)
PNK
RED
RED
JUNCTION BLOCK
TO INSTRUMENT CLUSTER
BLU/GRN
STARTER MOTOR
ORG
RED
RED
RED
RED
BLU
BATTERY
TO ECC CONTROL UNIT
ALTERNATOR
BLU
BLU/YEL
TEMPERATURE SENSOR
TO TEST CONNECTOR
BLU/YEL
BRN
PNK
MASS AIR FLOW METER
OXYGEN SENSOR (LAMBDA-SOND)
YEL/RED
BLK
BRN
ORG
GRY
RED/WHT
BRN
BLU/YEL
BLU/GRN
BLU/RED
BLU/WHT
WHT
BLK
BLK
BLK
3
2
12
25
23
9
6
7
8
14
11
20
19
5
FUEL INJECTION MODULE (LH-JETRONIC)
22
1
21
17
24
10
13
18
RED
GRY
FUEL INJECTOR
FUEL INJECTOR
IDLE AIR CONTROL VALVE
YEL/BLK
GRN
YEL/RED
GRN
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR

Fig. 138 Engine wiring — 1988 760 sedan and wagon; 780 coupe (2.8L LH-Jetronic turbo)

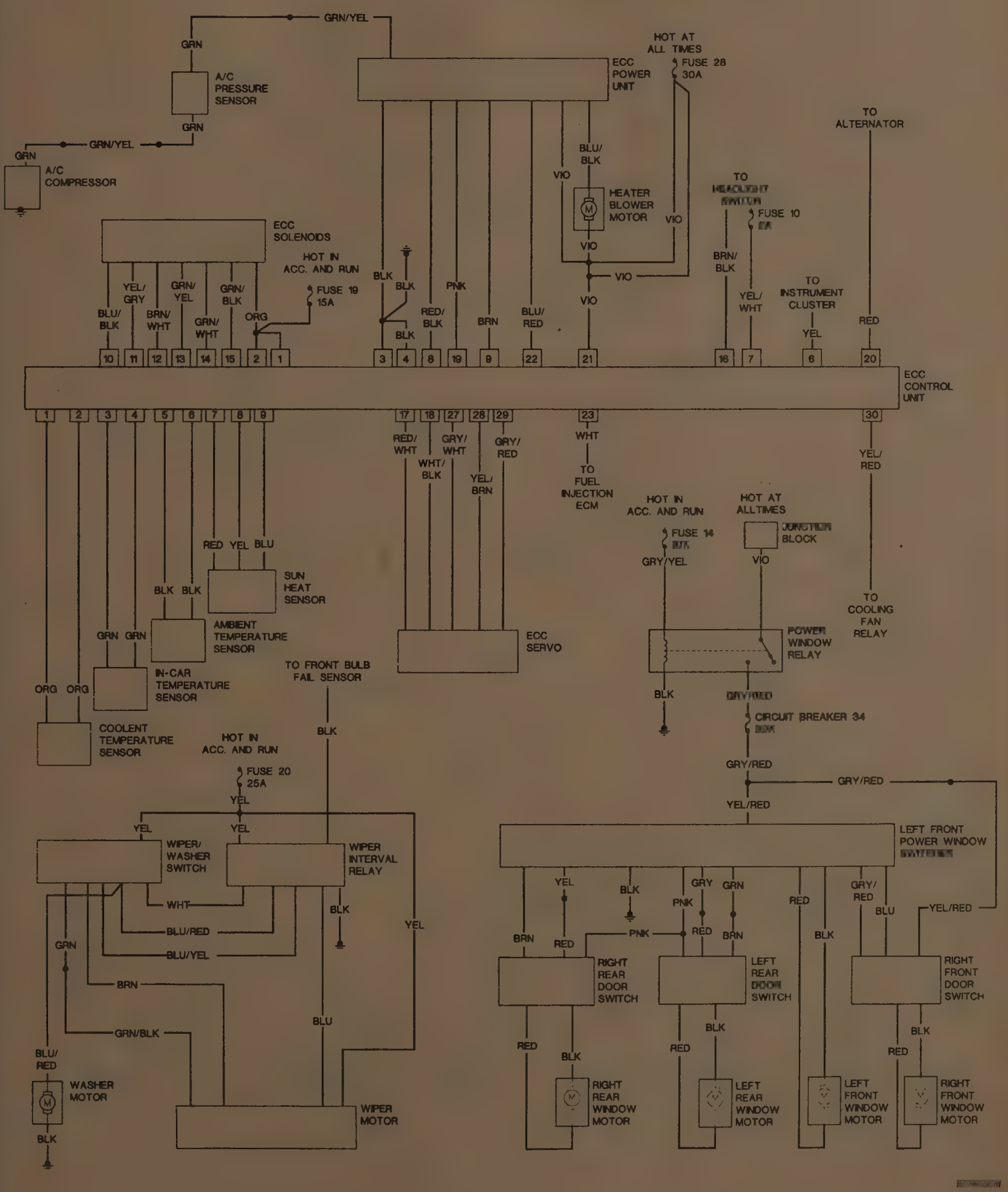

GRN/YEL
GRN
A/C PRESSURE SENSOR
GRN
GRN/YEL
GRN
A/C COMPRESSOR
ECC POWER UNIT
HOT AT ALL TIMES
FUSE 28 30A
TO ALTERNATOR
BLU/BLK
VIO
HEATER BLOWER MOTOR
VIO
VIO
VIO
VIO
TO HEADLIGHT SWITCH
FUSE 10
BRN/BLK
YEL/WHT
TO INSTRUMENT CLUSTER
YEL
RED
ECC SOLENOIDS
HOT IN ACC. AND RUN
FUSE 19 15A
BLU/BLK
YEL/GRY
BRN/WHT
GRN/YEL
GRN/WHT
GRN/BLK
ORG
BLK
BLK
BLK
RED/BLK
PNK
BRN
BLU/RED
10
11
12
13
14
15
2
1
3
4
8
19
9
22
21
16
7
6
20
ECC CONTROL UNIT
1
2
3
4
5
6
7
8
9
17
18
27
28
29
23
30
RED/WHT
WHT/BLK
GRY/WHT
YEL/BRN
GRY/RED
WHT
TO FUEL INJECTION ECM
YEL/RED
HOT IN ACC. AND RUN
FUSE 14
GRY/YEL
HOT AT ALLTIMES
JUNCTION BLOCK
VIO
TO COOLING FAN RELAY
POWER WINDOW RELAY
BLK
GRY/RED
CIRCUIT BREAKER 34
GRY/RED
GRY/RED
YEL/RED
RED
YEL
BLU
SUN HEAT SENSOR
BLK
BLK
AMBIENT TEMPERATURE SENSOR
GRN
GRN
IN-CAR TEMPERATURE SENSOR
ORG
ORG
COOLANT TEMPERATURE SENSOR
ECC SERVO
TO FRONT BULB FAIL SENSOR
BLK
HOT IN ACC. AND RUN
FUSE 20 25A
YEL
YEL
YEL
WIPER/WASHER SWITCH
WIPER INTERVAL RELAY
WHT
BLU/RED
BLU/YEL
BLK
YEL
GRN
BRN
GRN/BLK
BLU
BLU/RED
WASHER MOTOR
BLK
WIPER MOTOR
LEFT FRONT POWER WINDOW SWITCHES
YEL
BLK
GRY
GRN
PNK
RED
GRY/RED
BLU
YEL/RED
BRN
RED
PNK
RED
BRN
BLK
RIGHT REAR DOOR SWITCH
LEFT REAR DOOR SWITCH
RIGHT FRONT DOOR SWITCH
RED
BLK
RED
BLK
RED
BLK
RIGHT REAR WINDOW MOTOR
LEFT REAR WINDOW MOTOR
LEFT FRONT WINDOW MOTOR
RIGHT FRONT WINDOW MOTOR

Fig. 139 Chassis wiring — 1988 760 GLE sedan and wagon; 780 GLE and coupe

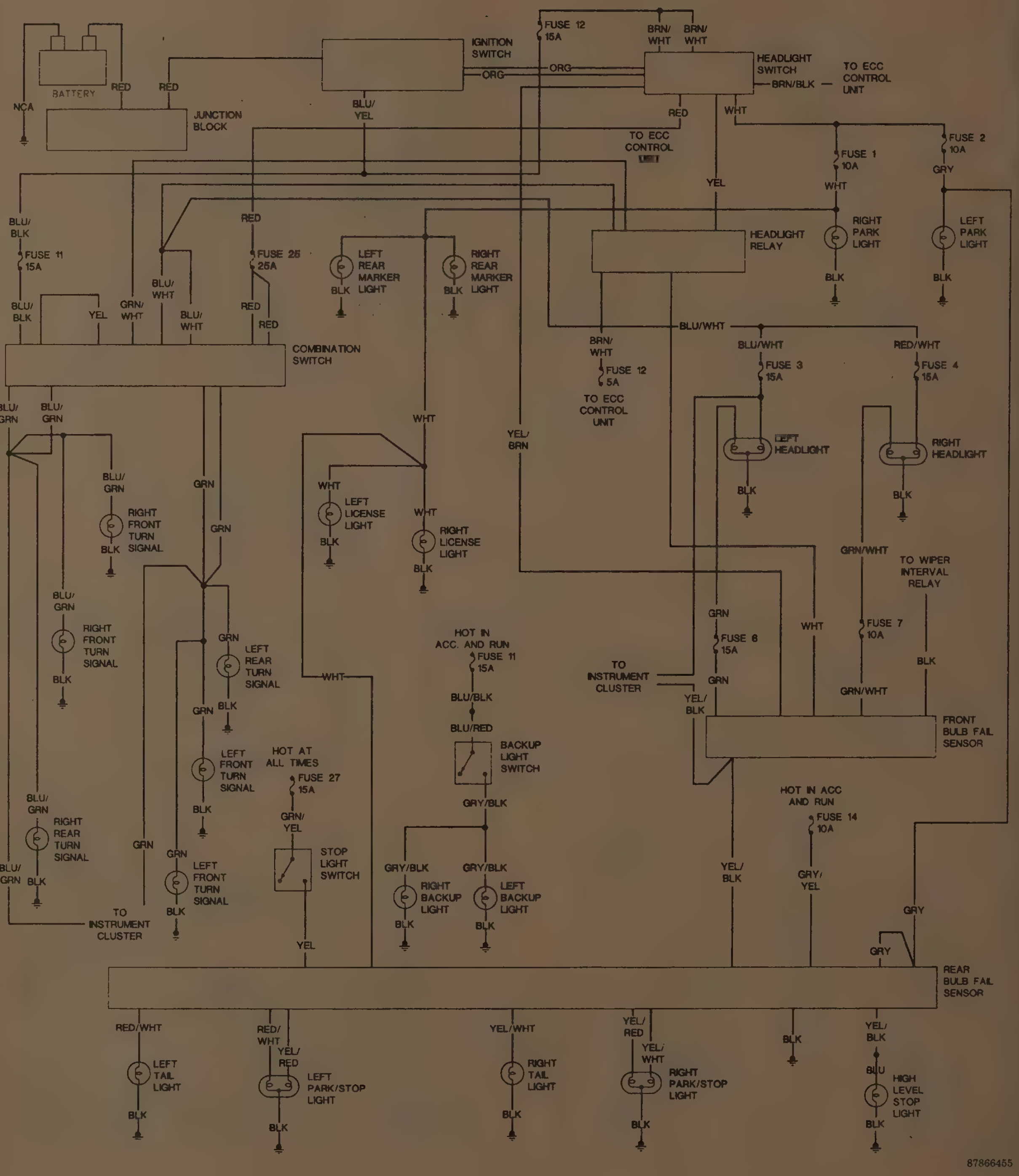

BATTERY
NCA
RED
RED
JUNCTION BLOCK
IGNITION SWITCH
BLU/YEL
ORG
ORG
FUSE 12 15A
BRN/WHT
BRN/WHT
HEADLIGHT SWITCH
BRN/BLK
TO ECC CONTROL UNIT
RED
WHT
TO ECC CONTROL UNIT
FUSE 1 10A
FUSE 2 10A
GRY
WHT
YEL
RIGHT PARK LIGHT
LEFT PARK LIGHT
HEADLIGHT RELAY
BLK
BLK
BLU/BLK
FUSE 11 15A
BLU/BLK
YEL
GRN/WHT
BLU/WHT
BLU/WHT
RED
FUSE 25 25A
RED
RED
LEFT REAR MARKER LIGHT
BLK
RIGHT REAR MARKER LIGHT
BLK
COMBINATION SWITCH
BLU/WHT
BRN/WHT
FUSE 12 5A
TO ECC CONTROL UNIT
BLU/WHT
FUSE 3 15A
RED/WHT
FUSE 4 15A
LEFT HEADLIGHT
RIGHT HEADLIGHT
BLK
BLK
BLU/GRN
BLU/GRN
WHT
YEL/BRN
BLU/GRN
RIGHT FRONT TURN SIGNAL
BLK
GRN
GRN
WHT
LEFT LICENSE LIGHT
BLK
WHT
RIGHT LICENSE LIGHT
BLK
GRN/WHT
TO WIPER INTERVAL RELAY
BLU/GRN
RIGHT FRONT TURN SIGNAL
BLK
GRN
LEFT REAR TURN SIGNAL
BLK
GRN
HOT IN ACC. AND RUN
FUSE 11 15A
BLU/BLK
BLU/RED
BACKUP LIGHT SWITCH
TO INSTRUMENT CLUSTER
GRN
FUSE 6 15A
GRN
YEL/BLK
WHT
FUSE 7 10A
GRN/WHT
BLK
FRONT BULB FAIL SENSOR
WHT
LEFT FRONT TURN SIGNAL
BLK
HOT AT ALL TIMES
FUSE 27 15A
GRN/YEL
STOP LIGHT SWITCH
GRY/BLK
GRY/BLK
GRY/BLK
RIGHT BACKUP LIGHT
BLK
LEFT BACKUP LIGHT
BLK
HOT IN ACC AND RUN
FUSE 14 10A
GRY/YEL
YEL/BLK
GRY
GRY
BLU/GRN
RIGHT REAR TURN SIGNAL
BLU/GRN
BLK
GRN
GRN
LEFT FRONT TURN SIGNAL
BLK
TO INSTRUMENT CLUSTER
YEL
REAR BULB FAIL SENSOR
RED/WHT
LEFT TAIL LIGHT
BLK
RED/WHT
YEL/RED
LEFT PARK/STOP LIGHT
BLK
YEL/WHT
RIGHT TAIL LIGHT
BLK
YEL/RED
YEL/WHT
RIGHT PARK/STOP LIGHT
BLK
BLK
YEL/BLK
BLU
HIGH LEVEL STOP LIGHT
BLK
87866455

Fig. 140 Chassis wiring — 1988 760 GLE sedan and wagon; 780 GLE and coupe (continued)

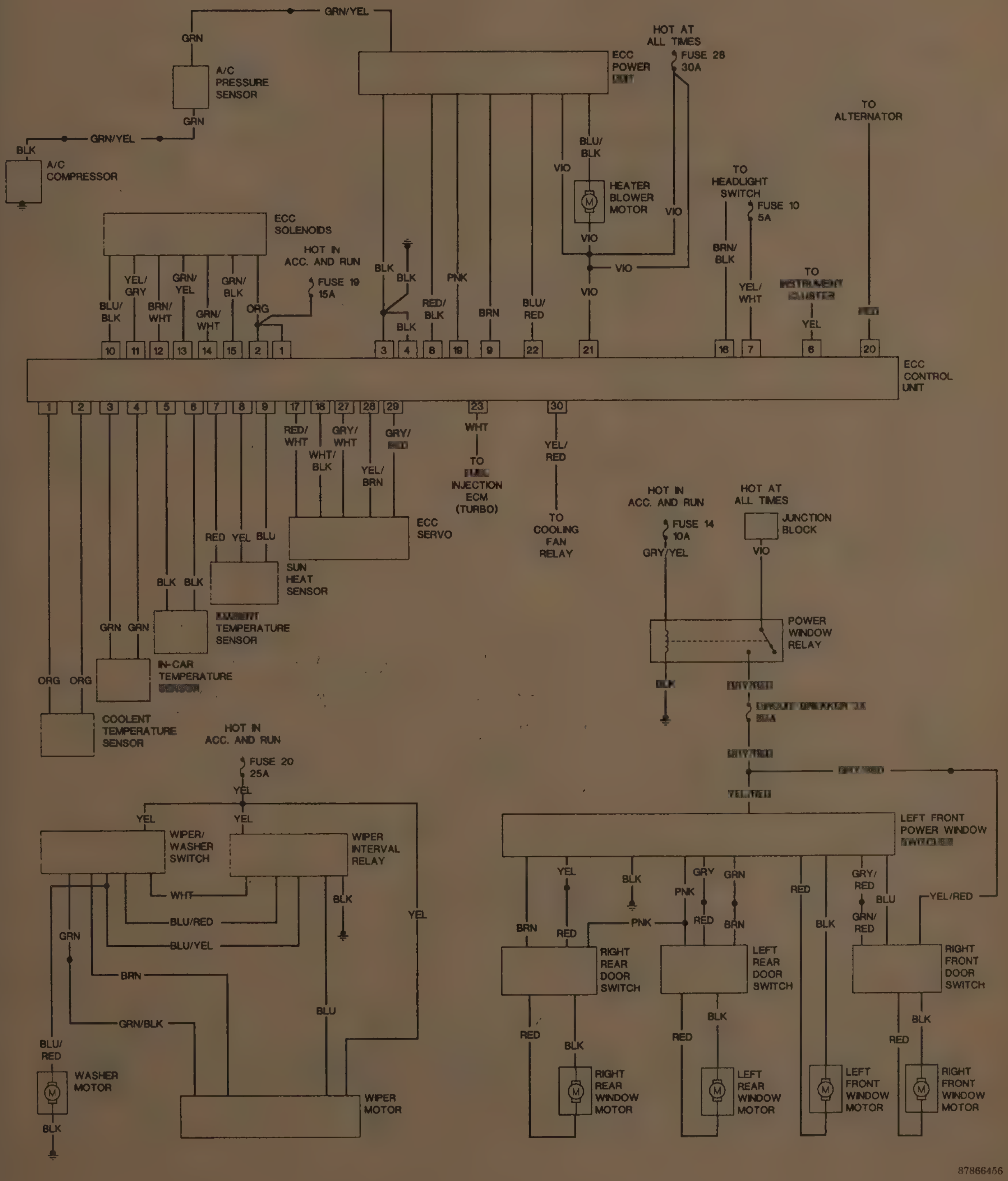

GRN/YEL
GRN
A/C PRESSURE SENSOR
GRN
GRN/YEL
BLK
A/C COMPRESSOR
ECC POWER UNIT
HOT AT ALL TIMES
FUSE 28 30A
BLU/BLK
VIO
HEATER BLOWER MOTOR
VIO
VIO
VIO
VIO
TO ALTERNATOR
TO HEADLIGHT SWITCH
FUSE 10 5A
BRN/BLK
YEL/WHT
TO INSTRUMENT CLUSTER
YEL
RED
ECC SOLENOIDS
HOT IN ACC. AND RUN
FUSE 19 15A
YEL/GRY
GRN/YEL
GRN/BLK
BLU/BLK
BRN/WHT
GRN/WHT
ORG
BLK
BLK
BLK
PNK
RED/BLK
BRN
BLU/RED
10
11
12
13
14
15
2
1
3
4
8
19
9
22
21
16
7
6
20
ECC CONTROL UNIT
1
2
3
4
5
6
7
8
9
17
18
27
28
29
23
30
RED/WHT
GRY/WHT
WHT/BLK
YEL/BRN
GRY/RED
WHT
TO FUEL INJECTION ECM (TURBO)
YEL/RED
TO COOLING FAN RELAY
ECC SERVO
RED
YEL
BLU
SUN HEAT SENSOR
BLK
BLK
AMBIENT TEMPERATURE SENSOR
GRN
GRN
IN-CAR TEMPERATURE SENSOR
ORG
ORG
COOLANT TEMPERATURE SENSOR
HOT IN ACC. AND RUN
FUSE 14 10A
GRY/YEL
HOT AT ALL TIMES
JUNCTION BLOCK
VIO
POWER WINDOW RELAY
BLK
GRY/RED
CIRCUIT BREAKER 3X 30A
GRY/RED
GRY/RED
YEL/RED
HOT IN ACC. AND RUN
FUSE 20 25A
YEL
YEL
YEL
WIPER/WASHER SWITCH
WIPER INTERVAL RELAY
WHT
BLU/RED
BLU/YEL
BLK
YEL
GRN
BRN
GRN/BLK
BLU
BLU/RED
WASHER MOTOR
BLK
WIPER MOTOR
LEFT FRONT POWER WINDOW SWITCHES
YEL
BLK
GRY
GRN
PNK
GRY/RED
BLU
YEL/RED
RED
BRN
RED
PNK
RED
BRN
BLK
GRN/RED
RIGHT REAR DOOR SWITCH
LEFT REAR DOOR SWITCH
RIGHT FRONT DOOR SWITCH
RED
BLK
BLK
RED
RED
BLK
RIGHT REAR WINDOW MOTOR
LEFT REAR WINDOW MOTOR
LEFT FRONT WINDOW MOTOR
RIGHT FRONT WINDOW MOTOR
87866456

Fig. 141 Chassis wiring — 1989 760 GLE sedan and wagon; 780 GLE and coupe

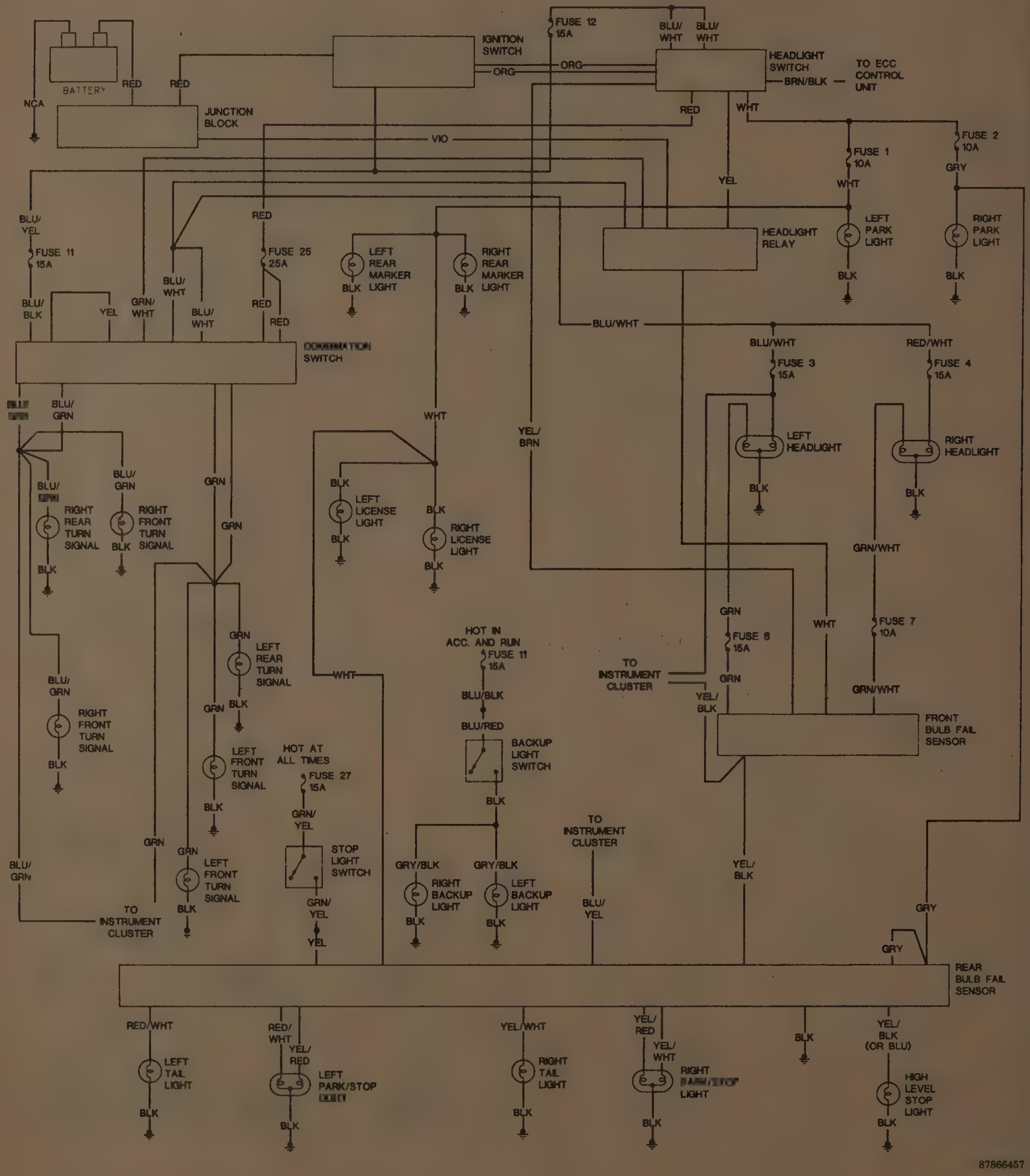

BATTERY
NCA
RED
RED
JUNCTION BLOCK
IGNITION SWITCH
ORG
ORG
VIO
FUSE 12 15A
BLU/ WHT
BLU/ WHT
HEADLIGHT SWITCH
TO ECC CONTROL UNIT
BRN/BLK
RED
WHT
FUSE 1 10A
WHT
FUSE 2 10A
GRY
YEL
HEADLIGHT RELAY
LEFT PARK LIGHT
BLK
RIGHT PARK LIGHT
BLK
BLU/ YEL
FUSE 11 15A
BLU/ BLK
YEL
GRN/ WHT
BLU/ WHT
BLU/ WHT
RED
FUSE 25 25A
RED
RED
LEFT REAR MARKER LIGHT
BLK
RIGHT REAR MARKER LIGHT
BLK
BLU/WHT
COMBINATION SWITCH
BLU/WHT
FUSE 3 15A
RED/WHT
FUSE 4 15A
BLU/ GRN
BLU/ GRN
WHT
YEL/ BRN
LEFT HEADLIGHT
BLK
RIGHT HEADLIGHT
BLK
BLU/ GRN
BLU/ GRN
GRN
GRN
RIGHT REAR TURN SIGNAL
BLK
RIGHT FRONT TURN SIGNAL
BLK
BLK
LEFT LICENSE LIGHT
BLK
BLK
RIGHT LICENSE LIGHT
BLK
GRN/WHT
GRN
FUSE 6 15A
WHT
FUSE 7 10A
GRN
LEFT REAR TURN SIGNAL
HOT IN ACC. AND RUN
FUSE 11 15A
TO INSTRUMENT CLUSTER
GRN
YEL/ BLK
GRN/WHT
WHT
BLU/ GRN
RIGHT FRONT TURN SIGNAL
BLK
GRN
BLK
BLU/BLK
BLU/RED
FRONT BULB FAIL SENSOR
LEFT FRONT TURN SIGNAL
HOT AT ALL TIMES
FUSE 27 15A
BACKUP LIGHT SWITCH
BLK
BLK
GRN/ YEL
TO INSTRUMENT CLUSTER
GRN
GRN
STOP LIGHT SWITCH
GRY/BLK
GRY/BLK
YEL/ BLK
BLU/ GRN
LEFT FRONT TURN SIGNAL
RIGHT BACKUP LIGHT
LEFT BACKUP LIGHT
TO INSTRUMENT CLUSTER
BLK
GRN/ YEL
BLU/ YEL
GRY
BLK
BLK
YEL
GRY
REAR BULB FAIL SENSOR
RED/WHT
RED/ WHT
YEL/ RED
YEL/WHT
YEL/ RED
YEL/ WHT
BLK
YEL/ BLK (OR BLU)
LEFT TAIL LIGHT
LEFT PARK/STOP LIGHT
RIGHT TAIL LIGHT
RIGHT PARK/STOP LIGHT
HIGH LEVEL STOP LIGHT
BLK
BLK
BLK
BLK
BLK
87866457

Fig. 142 Chassis wiring — 1989 760 GLE sedan and wagon; 780 GLE and coupe (continued)

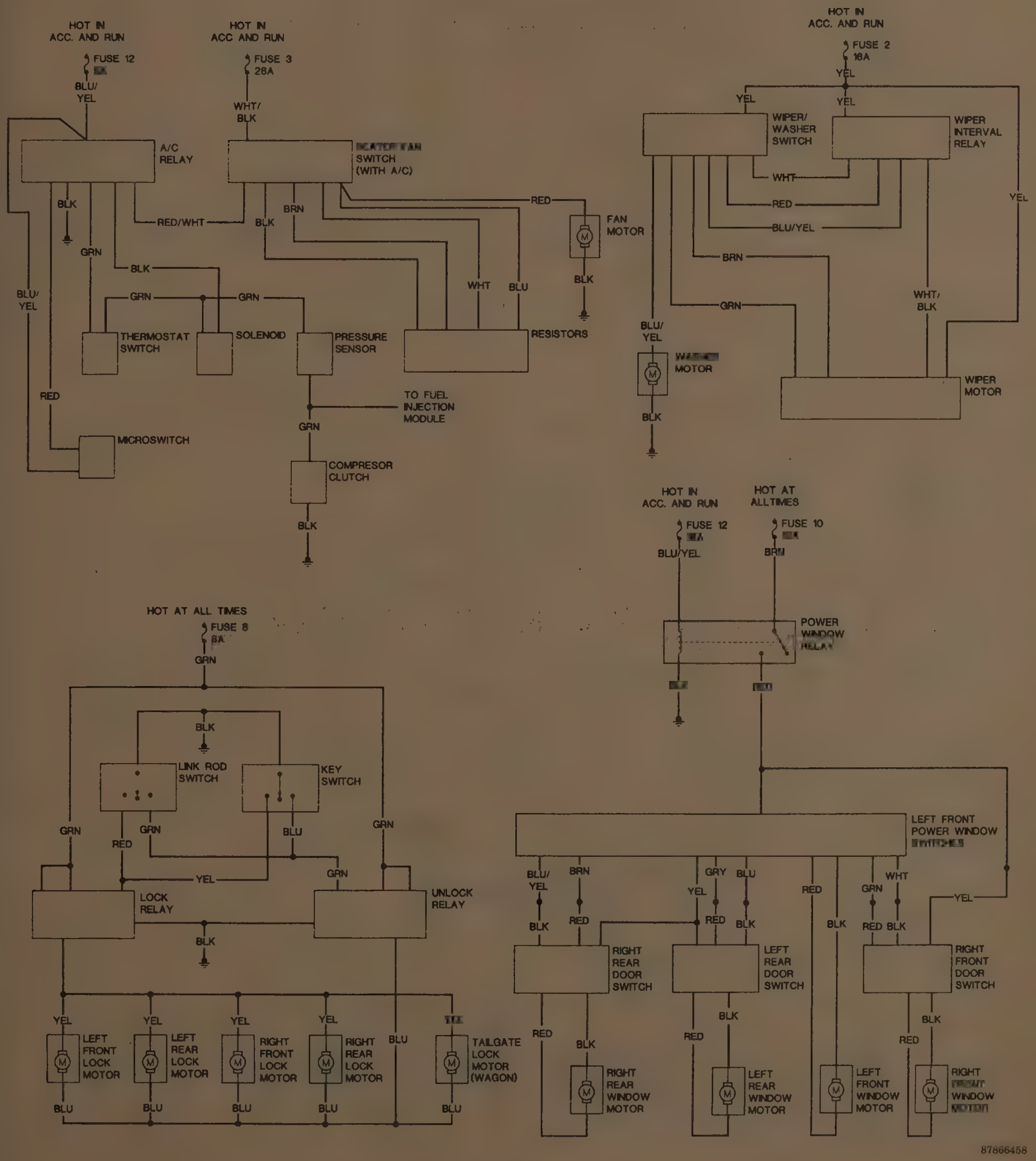

HOT IN ACC. AND RUN
FUSE 12
BLU/YEL
A/C RELAY
BLK
GRN
RED/WHT
BLK
GRN
GRN
BLU/YEL
THERMOSTAT SWITCH
SOLENOID
RED
MICROSWITCH
HOT IN ACC AND RUN
FUSE 3 25A
WHT/BLK
SWITCH (WITH A/C)
BRN
BLK
RED
FAN MOTOR
BLK
WHT
BLU
PRESSURE SENSOR
RESISTORS
TO FUEL INJECTION MODULE
GRN
COMPRESOR CLUTCH
BLK
HOT IN ACC. AND RUN
FUSE 2 16A
YEL
YEL
YEL
WIPER/WASHER SWITCH
WIPER INTERVAL RELAY
WHT
RED
BLU/YEL
YEL
BRN
GRN
WHT/BLK
BLU/YEL
MOTOR
BLK
WIPER MOTOR
HOT IN ACC. AND RUN
FUSE 12
BLU/YEL
HOT AT ALLTIMES
FUSE 10
BRN
POWER WINDOW
HOT AT ALL TIMES
FUSE 8
GRN
BLK
LINK ROD SWITCH
KEY SWITCH
GRN
RED
GRN
BLU
GRN
YEL
GRN
LOCK RELAY
UNLOCK RELAY
BLK
YEL
YEL
YEL
YEL
LEFT FRONT LOCK MOTOR
LEFT REAR LOCK MOTOR
RIGHT FRONT LOCK MOTOR
RIGHT REAR LOCK MOTOR
BLU
TAILGATE LOCK MOTOR (WAGON)
BLU
BLU
BLU
BLU
BLU
LEFT FRONT POWER WINDOW
BLU/YEL
BRN
GRY
BLU
YEL
RED
GRN
WHT
YEL
BLK
RED
RED
BLK
BLK
RED
BLK
RIGHT REAR DOOR SWITCH
LEFT REAR DOOR SWITCH
RIGHT FRONT DOOR SWITCH
RED
BLK
RED
BLK
RED
BLK
RIGHT REAR WINDOW MOTOR
LEFT REAR WINDOW MOTOR
LEFT FRONT WINDOW MOTOR
RIGHT WINDOW
87866458

Fig. 143 Chassis wiring — 1989 240 DL/GL sedan and wagon

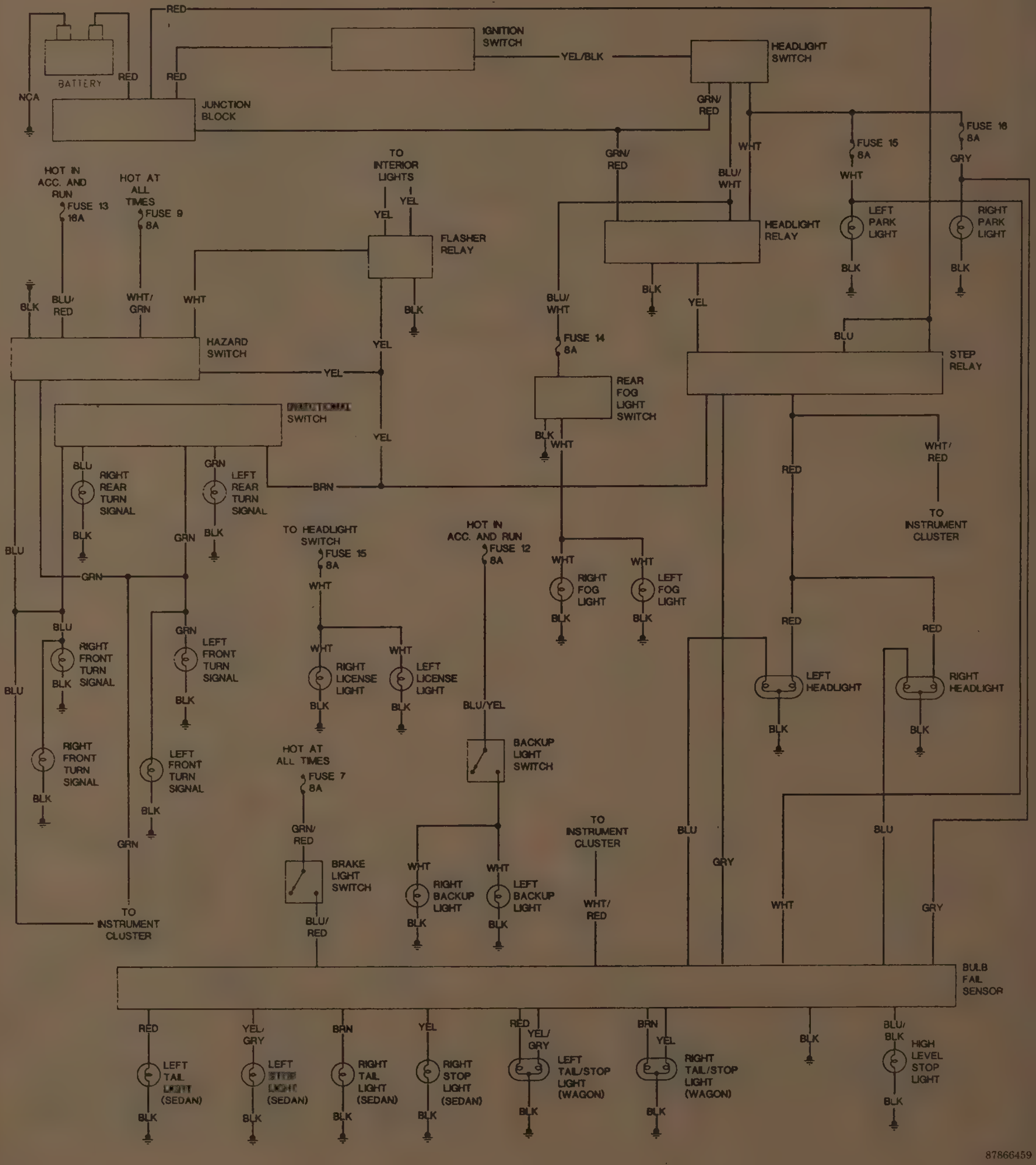

RED
BATTERY
RED
RED
NCA
JUNCTION BLOCK
IGNITION SWITCH
YEL/BLK
HEADLIGHT SWITCH
GRN/RED
GRN/RED
WHT
BLU/WHT
FUSE 15 8A
WHT
FUSE 16 8A
GRY
LEFT PARK LIGHT
RIGHT PARK LIGHT
BLK
BLK
HEADLIGHT RELAY
BLK
YEL
BLU/WHT
FUSE 14 8A
REAR FOG LIGHT SWITCH
BLK
WHT
BLU
STEP RELAY
HOT IN ACC. AND RUN
FUSE 13 16A
HOT AT ALL TIMES
FUSE 9 8A
TO INTERIOR LIGHTS
YEL
YEL
FLASHER RELAY
BLK
BLK
BLU/RED
WHT/GRN
WHT
HAZARD SWITCH
YEL
YEL
DIRECTIONAL SWITCH
YEL
BLU
RIGHT REAR TURN SIGNAL
GRN
LEFT REAR TURN SIGNAL
BRN
BLK
BLK
GRN
BLU
GRN
BLU
RIGHT FRONT TURN SIGNAL
BLK
GRN
LEFT FRONT TURN SIGNAL
BLK
BLU
RIGHT FRONT TURN SIGNAL
BLK
LEFT FRONT TURN SIGNAL
BLK
GRN
TO INSTRUMENT CLUSTER
TO HEADLIGHT SWITCH
FUSE 15 8A
WHT
WHT
WHT
RIGHT LICENSE LIGHT
LEFT LICENSE LIGHT
BLK
BLK
HOT IN ACC. AND RUN
FUSE 12 8A
BLU/YEL
BACKUP LIGHT SWITCH
HOT AT ALL TIMES
FUSE 7 8A
GRN/RED
BRAKE LIGHT SWITCH
BLU/RED
WHT
WHT
RIGHT BACKUP LIGHT
LEFT BACKUP LIGHT
BLK
BLK
TO INSTRUMENT CLUSTER
WHT/RED
WHT
WHT
RIGHT FOG LIGHT
LEFT FOG LIGHT
BLK
BLK
RED
WHT/RED
TO INSTRUMENT CLUSTER
RED
RED
LEFT HEADLIGHT
RIGHT HEADLIGHT
BLK
BLK
BLU
GRY
BLU
WHT
GRY
BULB FAIL SENSOR
RED
LEFT TAIL LIGHT (SEDAN)
YEL/GRY
LEFT STOP LIGHT (SEDAN)
BRN
RIGHT TAIL LIGHT (SEDAN)
YEL
RIGHT STOP LIGHT (SEDAN)
RED
YEL/GRY
LEFT TAIL/STOP LIGHT (WAGON)
BRN
YEL
RIGHT TAIL/STOP LIGHT (WAGON)
BLK
BLU/BLK
HIGH LEVEL STOP LIGHT
BLK
BLK
BLK
BLK
BLK
BLK
BLK
87866459

Fig. 144 Chassis wiring — 1989 240 DL/GL sedan and wagon (continued)

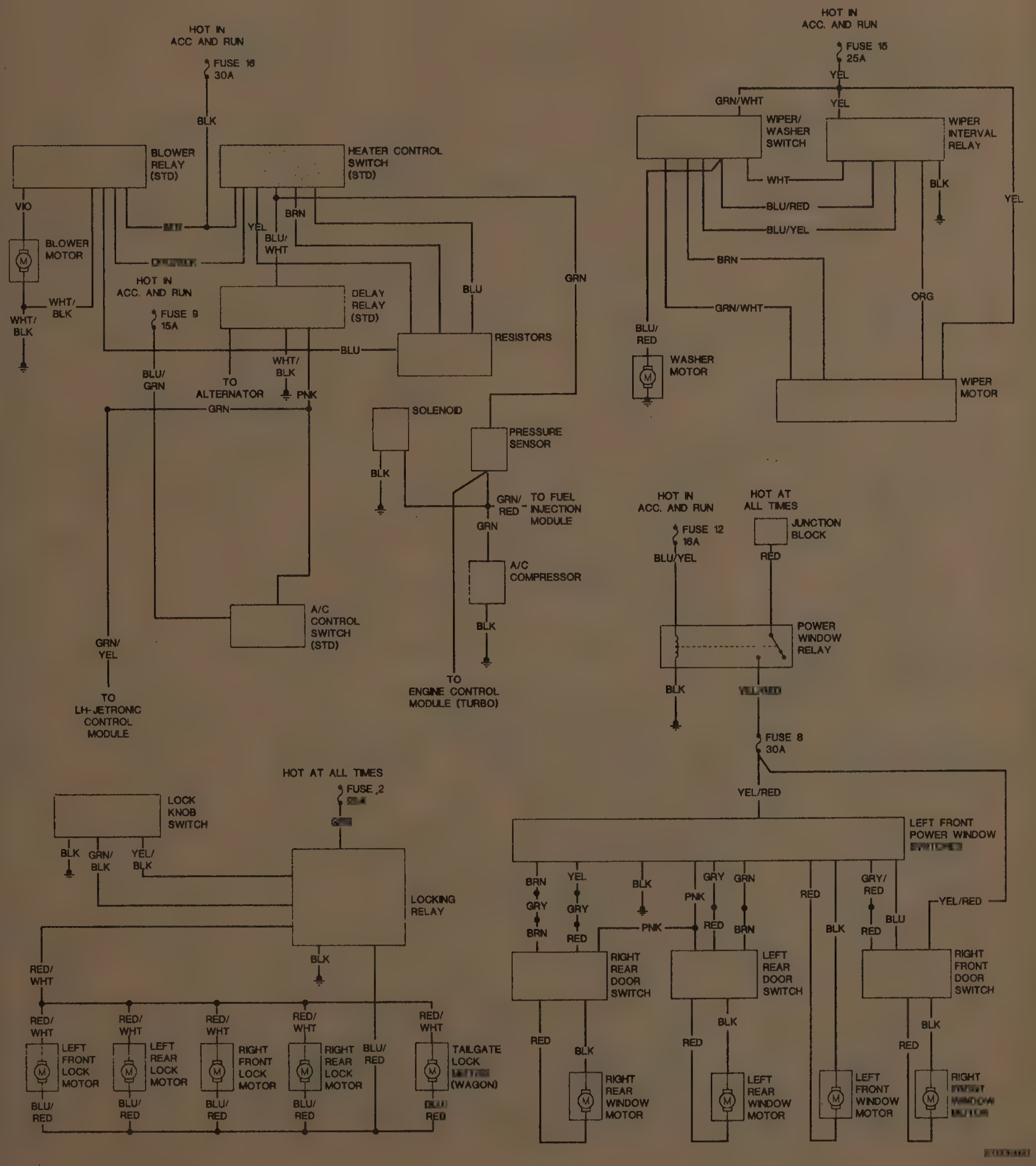

HOT IN
ACC AND RUN
FUSE 16
30A
BLK
BLOWER
RELAY
(STD)
HEATER CONTROL
SWITCH
(STD)
VIO
BLOWER
MOTOR
WHT/
BLK
WHT/
BLK
YEL
BRN
BLU/
WHT
HOT IN
ACC. AND RUN
FUSE 9
15A
DELAY
RELAY
(STD)
BLU
GRN
BLU
RESISTORS
WHT/
BLK
BLU/
GRN
TO
ALTERNATOR
PNK
GRN
SOLENOID
PRESSURE
SENSOR
BLK
GRN/
RED
TO FUEL
INJECTION
MODULE
GRN
A/C
COMPRESSOR
BLK
A/C
CONTROL
SWITCH
(STD)
GRN/
YEL
TO
LH-JETRONIC
CONTROL
MODULE
TO
ENGINE CONTROL
MODULE (TURBO)
HOT IN
ACC. AND RUN
FUSE 15
25A
YEL
GRN/WHT
YEL
WIPER/
WASHER
SWITCH
WIPER
INTERVAL
RELAY
WHT
BLU/RED
BLU/YEL
BLK
YEL
BRN
ORG
GRN/WHT
BLU/
RED
WASHER
MOTOR
WIPER
MOTOR
HOT IN
ACC. AND RUN
HOT AT
ALL TIMES
JUNCTION
BLOCK
FUSE 12
16A
BLU/YEL
RED
POWER
WINDOW
RELAY
BLK
YEL/RED
FUSE 8
30A
YEL/RED
LEFT FRONT
POWER WINDOW
SWITCHES
BRN
GRY
BRN
YEL
GRY
RED
BLK
GRY
PNK
GRN
RED
BRN
PNK
RED
GRY/
RED
BLU
RED
YEL/RED
BLK
RIGHT
REAR
DOOR
SWITCH
LEFT
REAR
DOOR
SWITCH
RIGHT
FRONT
DOOR
SWITCH
RED
BLK
RED
BLK
RED
BLK
RIGHT
REAR
WINDOW
MOTOR
LEFT
REAR
WINDOW
MOTOR
LEFT
FRONT
WINDOW
MOTOR
RIGHT
FRONT
WINDOW
MOTOR
LOCK
KNOB
SWITCH
HOT AT ALL TIMES
FUSE 2
25A
GRN
BLK
GRN/
BLK
YEL/
BLK
LOCKING
RELAY
BLK
RED/
WHT
RED/
WHT
RED/
WHT
RED/
WHT
RED/
WHT
RED/
WHT
LEFT
FRONT
LOCK
MOTOR
LEFT
REAR
LOCK
MOTOR
RIGHT
FRONT
LOCK
MOTOR
RIGHT
REAR
LOCK
MOTOR
BLU/
RED
TAILGATE
LOCK
MOTOR
(WAGON)
BLU/
RED
BLU/
RED
BLU/
RED
BLU/
RED
BLU/
RED

Fig. 145 Chassis wiring — 1989 740 GL/GLE sedan and wagon

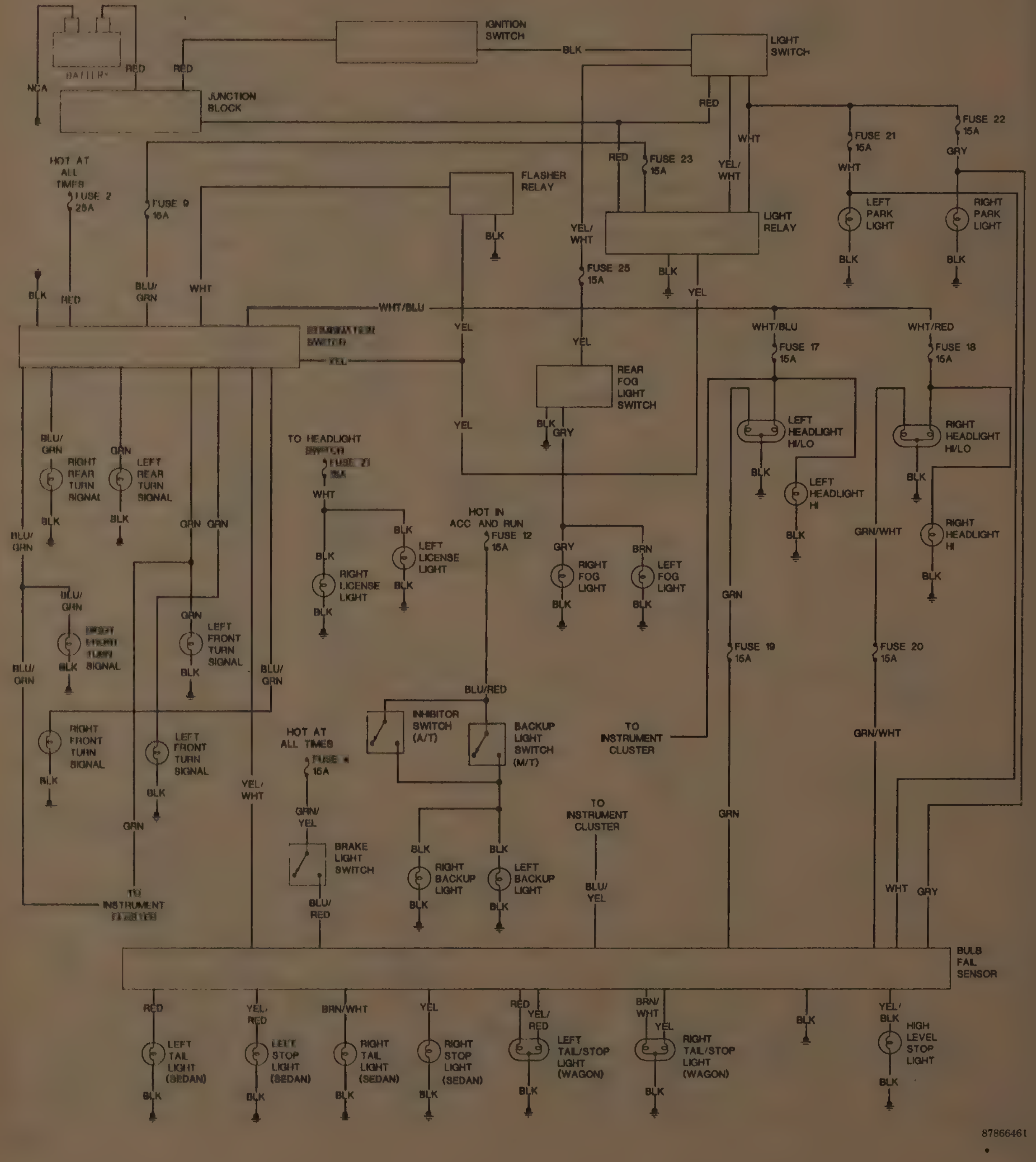

BATTERY
NCA
RED
RED
IGNITION SWITCH
BLK
LIGHT SWITCH
JUNCTION BLOCK
RED
WHT
FUSE 21 15A
FUSE 22 15A
GRY
RED
FUSE 23 15A
YEL/ WHT
WHT
HOT AT ALL TIMES
FUSE 2 25A
FUSE 9 15A
FLASHER RELAY
BLK
YEL/ WHT
LIGHT RELAY
LEFT PARK LIGHT
RIGHT PARK LIGHT
BLK
BLK
FUSE 25 15A
BLK
YEL
BLK
RED
BLU/ GRN
WHT
WHT/BLU
COMBINATION SWITCH
YEL
YEL
YEL
WHT/BLU
WHT/RED
FUSE 17 15A
FUSE 18 15A
REAR FOG LIGHT SWITCH
BLK
GRY
YEL
LEFT HEADLIGHT HI/LO
RIGHT HEADLIGHT HI/LO
BLU/ GRN
GRN
RIGHT REAR TURN SIGNAL
LEFT REAR TURN SIGNAL
TO HEADLIGHT SWITCH
FUSE 21 15A
WHT
BLK
BLK
LEFT HEADLIGHT HI
RIGHT HEADLIGHT HI
BLK
BLK
GRN
GRN
BLU/ GRN
BLK
LEFT LICENSE LIGHT
HOT IN ACC AND RUN
FUSE 12 15A
GRY
BRN
GRN/WHT
BLK
BLK
RIGHT LICENSE LIGHT
BLK
RIGHT FOG LIGHT
LEFT FOG LIGHT
BLK
BLU/ GRN
RIGHT FRONT TURN SIGNAL
GRN
LEFT FRONT TURN SIGNAL
BLK
BLK
BLK
GRN
FUSE 19 15A
FUSE 20 15A
BLU/ GRN
BLK
BLU/ GRN
BLU/RED
RIGHT FRONT TURN SIGNAL
INHIBITOR SWITCH (A/T)
BACKUP LIGHT SWITCH (M/T)
LEFT FRONT TURN SIGNAL
HOT AT ALL TIMES
FUSE 4 15A
TO INSTRUMENT CLUSTER
GRN/WHT
BLK
BLK
YEL/ WHT
GRN
GRN/ YEL
TO INSTRUMENT CLUSTER
GRN
BRAKE LIGHT SWITCH
BLK
BLK
RIGHT BACKUP LIGHT
LEFT BACKUP LIGHT
BLU/ YEL
BLK
BLK
TO INSTRUMENT CLUSTER
BLU/ RED
WHT
GRY
BULB FAIL SENSOR
RED
YEL/ RED
BRN/WHT
YEL
RED
YEL/ RED
BRN/ WHT
YEL
BLK
YEL/ BLK
LEFT TAIL LIGHT (SEDAN)
LEFT STOP LIGHT (SEDAN)
RIGHT TAIL LIGHT (SEDAN)
RIGHT STOP LIGHT (SEDAN)
LEFT TAIL/STOP LIGHT (WAGON)
RIGHT TAIL/STOP LIGHT (WAGON)
HIGH LEVEL STOP LIGHT
BLK
BLK
BLK
BLK
BLK
BLK
BLK
87866461

Fig. 146 Chassis wiring — 1989 740 GL/GLE sedan and wagon (continued)

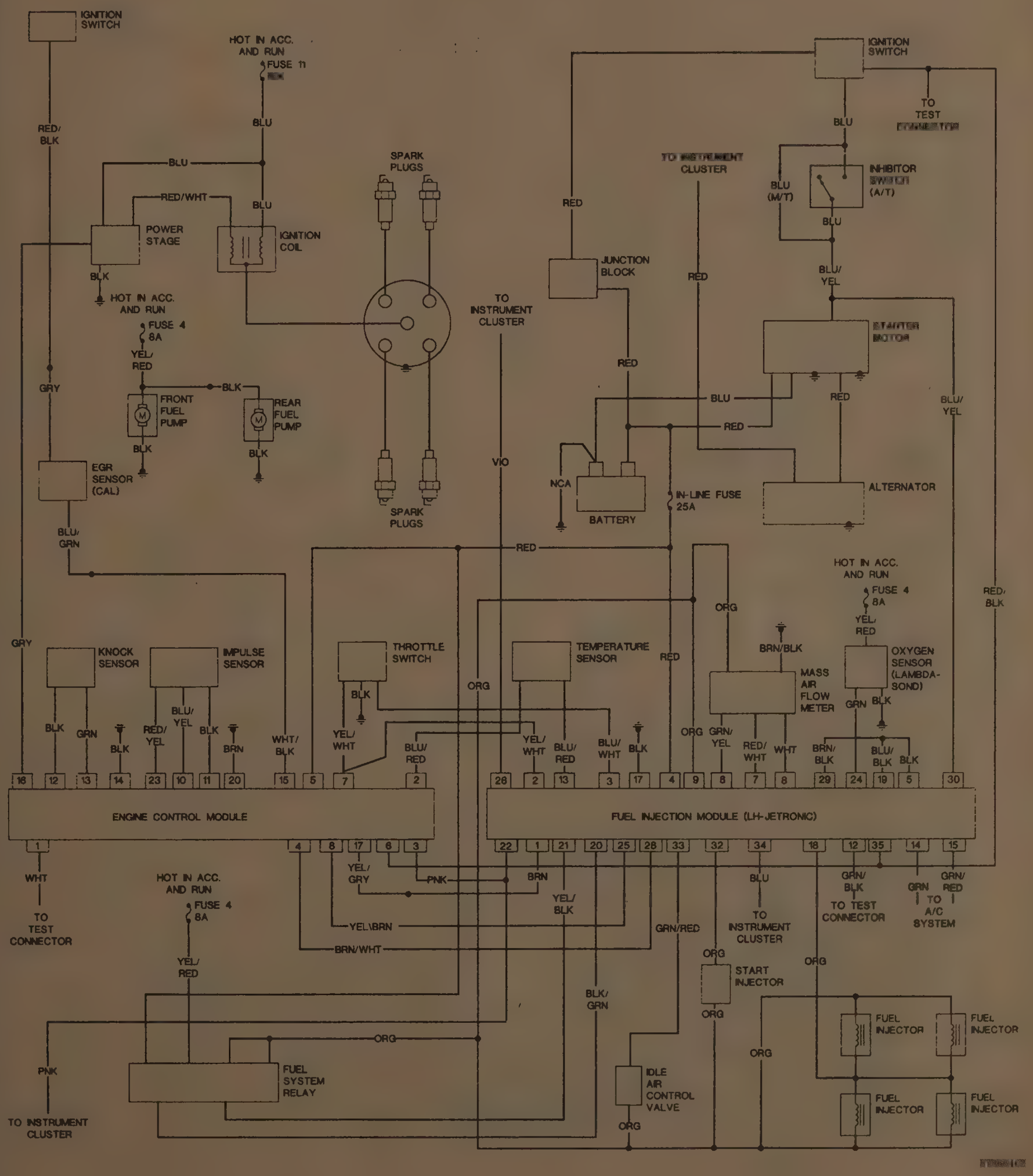

IGNITION SWITCH
HOT IN ACC. AND RUN
FUSE 11
BLU
RED/BLK
BLU
RED/WHT
BLU
POWER STAGE
IGNITION COIL
SPARK PLUGS
BLK
HOT IN ACC. AND RUN
FUSE 4 8A
YEL/RED
GRY
BLK
FRONT FUEL PUMP
REAR FUEL PUMP
BLK
BLK
EGR SENSOR (CAL)
BLU/GRN
SPARK PLUGS
TO INSTRUMENT CLUSTER
VIO
RED
IGNITION SWITCH
TO TEST CONNECTOR
BLU
TO INSTRUMENT CLUSTER
BLU (M/T)
INHIBITOR SWITCH (A/T)
BLU
RED
JUNCTION BLOCK
RED
BLU/YEL
STARTER MOTOR
RED
BLU
RED
RED
BLU/YEL
NCA
BATTERY
IN-LINE FUSE 25A
ALTERNATOR
HOT IN ACC. AND RUN
FUSE 4 8A
YEL/RED
RED/BLK
ORG
GRY
KNOCK SENSOR
IMPULSE SENSOR
THROTTLE SWITCH
TEMPERATURE SENSOR
RED
BRN/BLK
MASS AIR FLOW METER
OXYGEN SENSOR (LAMBDA-SOND)
ORG
BLK
BLK
GRN
BLK
RED/YEL
BLU/YEL
BLK
BRN
WHT/BLK
YEL/WHT
BLU/RED
YEL/WHT
BLU/RED
BLU/WHT
BLK
ORG
GRN/YEL
RED/WHT
WHT
BRN/BLK
GRN
BLK
BLU/BLK
BLK
18 12 13 14 23 10 11 20 15 5 7 2
26 2 13 3 17 4 9 8 7 8 29 24 19 5 30
ENGINE CONTROL MODULE
FUEL INJECTION MODULE (LH-JETRONIC)
1 4 8 17 6 3
22 1 21 20 25 28 33 32 34 18 12 35 14 15
WHT
TO TEST CONNECTOR
YEL/GRY
PNK
BRN
YEL/BLK
HOT IN ACC. AND RUN
FUSE 4 8A
YEL\BRN
BRN/WHT
GRN/RED
BLU
TO INSTRUMENT CLUSTER
GRN/BLK
TO TEST CONNECTOR
GRN
GRN/RED
TO A/C SYSTEM
YEL/RED
ORG
START INJECTOR
ORG
ORG
BLK/GRN
PNK
ORG
FUEL SYSTEM RELAY
TO INSTRUMENT CLUSTER
IDLE AIR CONTROL VALVE
ORG
ORG
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR

Fig. 147 Engine wiring — 1989 240 DL/GL sedan and wagon (2.3L)

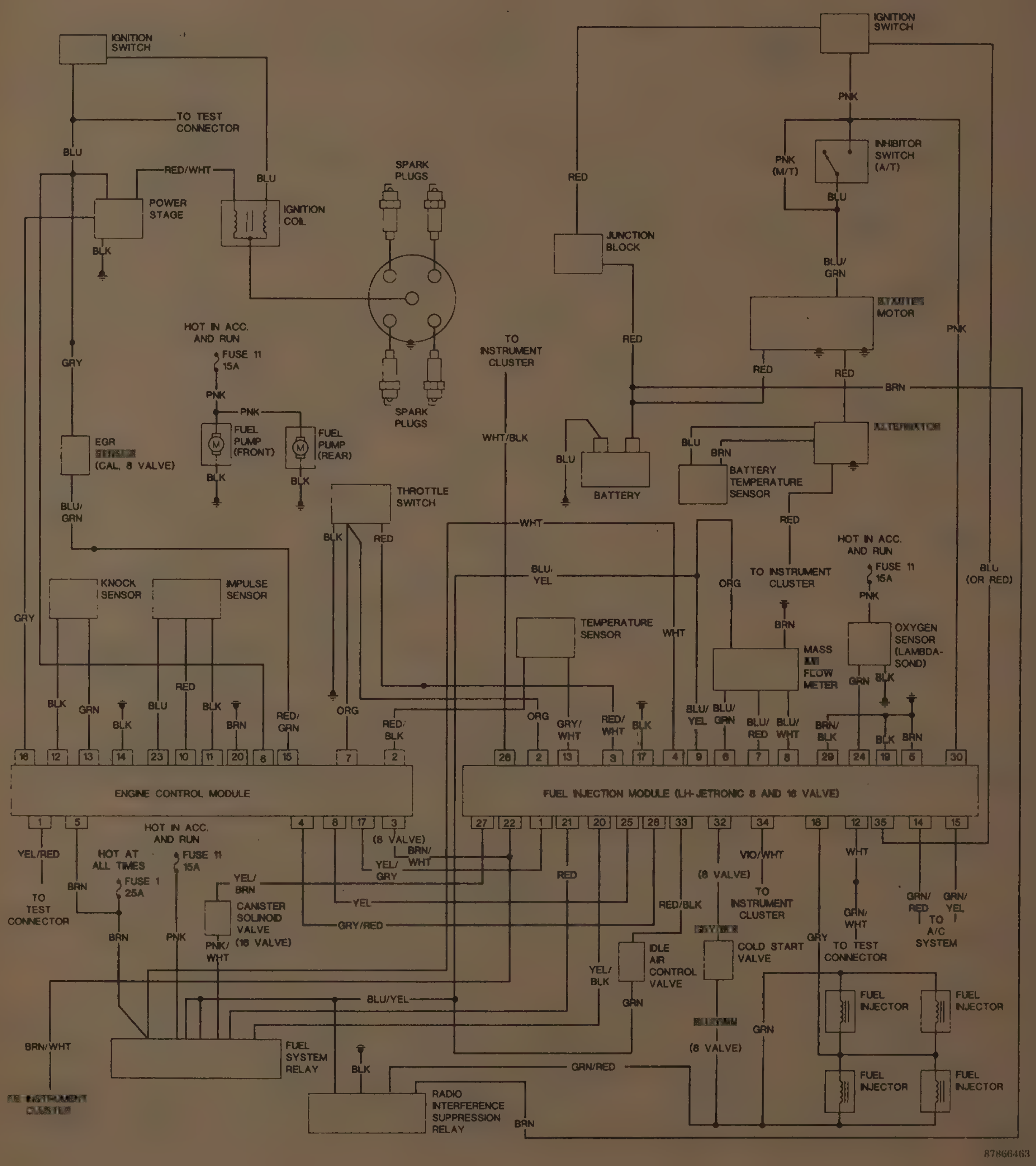

IGNITION SWITCH
TO TEST CONNECTOR
BLU
RED/WHT
BLU
POWER STAGE
IGNITION COIL
SPARK PLUGS
BLK
GRY
HOT IN ACC. AND RUN
FUSE 11 15A
PNK
PNK
FUEL PUMP (FRONT)
FUEL PUMP (REAR)
BLK
BLK
SPARK PLUGS
EGR SENSOR (CAL. 8 VALVE)
BLU/GRN
THROTTLE SWITCH
BLK
RED
KNOCK SENSOR
IMPULSE SENSOR
GRY
BLK
GRN
BLK
BLU
RED
BLK
BRN
RED/GRN
ORG
RED/BLK
ORG
GRY/WHT
RED/WHT
BLK
ENGINE CONTROL MODULE
YEL/RED
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 1 25A
BRN
BRN
HOT IN ACC. AND RUN
FUSE 11 15A
PNK
YEL/BRN
CANISTER SOLENOID VALVE (16 VALVE)
PNK/WHT
(8 VALVE)
BRN/WHT
YEL/GRY
YEL
GRY/RED
BLU/YEL
BRN/WHT
TO INSTRUMENT CLUSTER
FUEL SYSTEM RELAY
BLK
RADIO INTERFERENCE SUPPRESSION RELAY
BRN
GRN/RED
IGNITION SWITCH
PNK
RED
PNK (M/T)
INHIBITOR SWITCH (A/T)
BLU
BLU/GRN
JUNCTION BLOCK
STARTER MOTOR
PNK
RED
TO INSTRUMENT CLUSTER
WHT/BLK
RED
RED
BRN
ALTERNATOR
BLU
BLU
BRN
BATTERY
BATTERY TEMPERATURE SENSOR
RED
WHT
BLU/YEL
ORG
TO INSTRUMENT CLUSTER
HOT IN ACC. AND RUN
FUSE 11 15A
PNK
BLU (OR RED)
TEMPERATURE SENSOR
WHT
BRN
MASS AIR FLOW METER
OXYGEN SENSOR (LAMBDA-SOND)
GRN
BLK
BLU/YEL
BLU/GRN
BLU/RED
BLU/WHT
BRN/BLK
BLK
BRN
FUEL INJECTION MODULE (LH-JETRONIC 8 AND 16 VALVE)
16 12 13 14 23 10 11 20 8 15 7 2
1 5 4 8 17 3
26 2 13 3 17 4 9 6 7 8 29 24 19 5 30
27 22 1 21 20 25 28 33 32 34 18 12 35 14 15
RED
RED/BLK
(8 VALVE)
VIO/WHT
TO INSTRUMENT CLUSTER
WHT
GRN/WHT
GRY
TO TEST CONNECTOR
GRN/RED
GRN/YEL
TO A/C SYSTEM
IDLE AIR CONTROL VALVE
YEL/BLK
GRN
COLD START VALVE
(8 VALVE)
GRN
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
FUEL INJECTOR
87866463

Fig. 148 Engine wiring — 1989 740 DL/GL sedan and wagon (2.3L LH-Jetronic 8 and 16 valve)

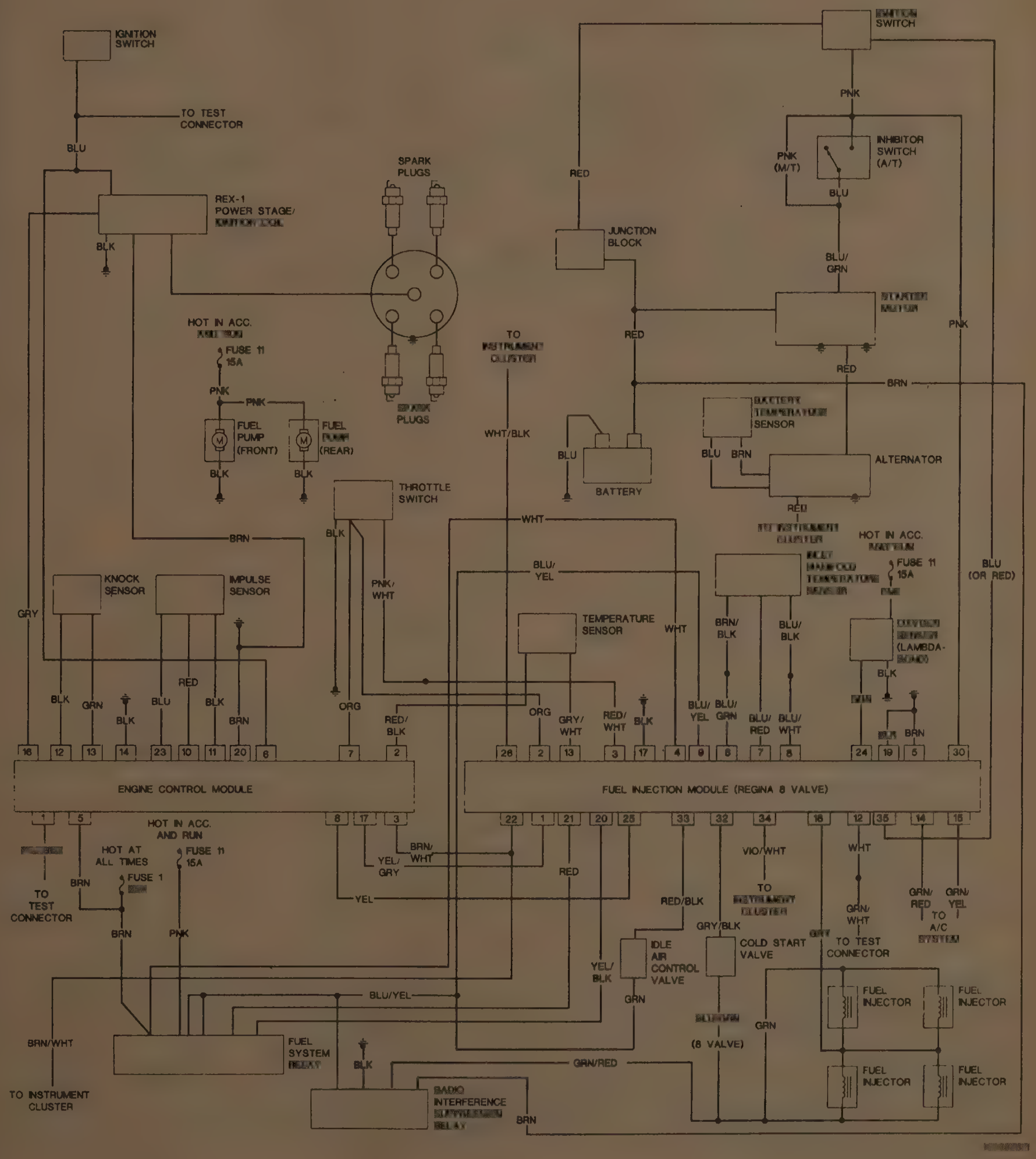
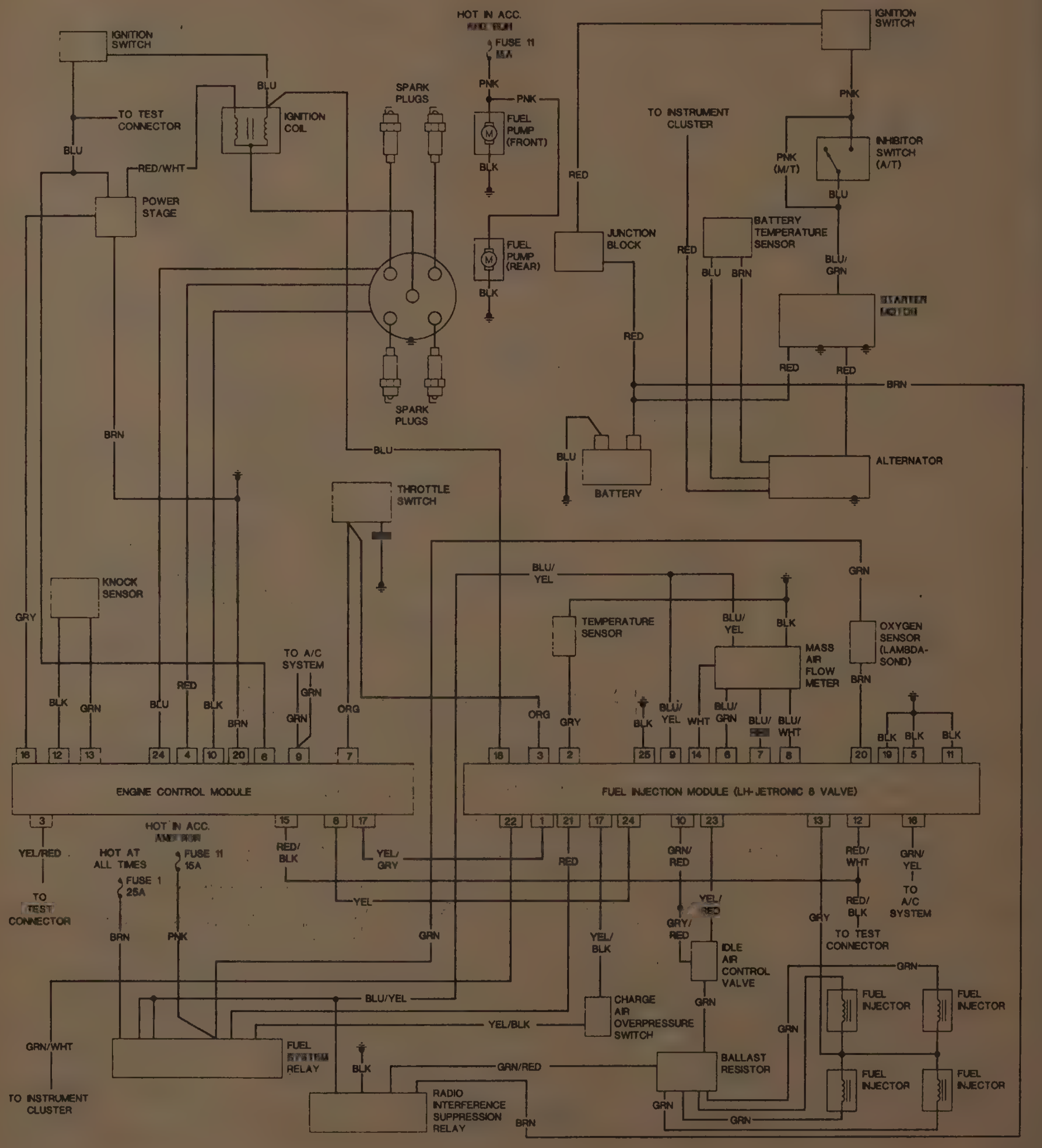

IGNITION SWITCH
TO TEST CONNECTOR
BLU
REX-1 POWER STAGE/ IGNITION COIL
BLK
SPARK PLUGS
HOT IN ACC. AND RUN
FUSE 11 15A
PNK
FUEL PUMP (FRONT)
FUEL PUMP (REAR)
TO INSTRUMENT CLUSTER
WHT/BLK
THROTTLE SWITCH
BRN
KNOCK SENSOR
IMPULSE SENSOR
GRY
GRN
RED
ORG
PNK/ WHT
RED/ BLK
IGNITION SWITCH
PNK (M/T)
INHIBITOR SWITCH (A/T)
BLU/ GRN
RED
JUNCTION BLOCK
STARTER MOTOR
BATTERY
BATTERY TEMPERATURE SENSOR
ALTERNATOR
TO INSTRUMENT CLUSTER
WHT
BLU/ YEL
TEMPERATURE SENSOR
INLET MANIFOLD TEMPERATURE SENSOR
HOT IN ACC. AND RUN
FUSE 11 15A
OXYGEN SENSOR (LAMBDA-SOND)
BRN/ BLK
BLU/ BLK
GRY/ WHT
RED/ WHT
BLU/ GRN
BLU/ RED
BLU/ WHT
BLU (OR RED)
ENGINE CONTROL MODULE
FUEL INJECTION MODULE (REGINA 8 VALVE)
16
12
13
14
23
10
11
20
6
7
2
26
2
13
3
17
4
9
6
7
8
24
19
5
30
1
5
8
17
3
22
1
21
20
25
33
32
34
18
12
35
14
15
HOT IN ACC. AND RUN
HOT AT ALL TIMES
FUSE 1
TO TEST CONNECTOR
YEL/ GRY
BRN/ WHT
YEL
VIO/WHT
RED/BLK
GRY/BLK
IDLE AIR CONTROL VALVE
COLD START VALVE
TO TEST CONNECTOR
GRN/ WHT
GRN/ RED
GRN/ YEL
TO A/C SYSTEM
YEL/ BLK
BLU/YEL
FUEL INJECTOR
FUEL SYSTEM RELAY
(8 VALVE)
BRN/WHT
TO INSTRUMENT CLUSTER
GRN/RED
RADIO INTERFERENCE SUPPRESSION RELAY

Fig. 149 Engine wiring — 1989 740 GL/GLE sedan and wagon (Regina)


HOT IN ACC.
FUSE 11
IGNITION SWITCH
TO TEST CONNECTOR
BLU
IGNITION COIL
SPARK PLUGS
PNK
FUEL PUMP (FRONT)
BLK
RED/WHT
POWER STAGE
FUEL PUMP (REAR)
RED
JUNCTION BLOCK
TO INSTRUMENT CLUSTER
PNK (M/T)
INHIBITOR SWITCH (A/T)
BATTERY TEMPERATURE SENSOR
BLU/GRN
BRN
STARTER MOTOR
ALTERNATOR
BATTERY
THROTTLE SWITCH
KNOCK SENSOR
GRY
GRN
TO A/C SYSTEM
ORG
TEMPERATURE SENSOR
BLU/YEL
MASS AIR FLOW METER
OXYGEN SENSOR (LAMBDA-SOND)
WHT
BLU/WHT
ENGINE CONTROL MODULE
FUEL INJECTION MODULE (LH-JETRONIC 8 VALVE)
16
12
13
24
4
10
20
6
9
7
18
3
2
25
14
8
20
19
5
11
15
17
22
1
21
23
YEL/RED
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 1 25A
FUSE 11 15A
RED/BLK
YEL/GRY
YEL
GRN/RED
YEL/BLK
GRY/RED
IDLE AIR CONTROL VALVE
RED/WHT
GRN/YEL
TO A/C SYSTEM
GRN/WHT
TO INSTRUMENT CLUSTER
FUEL SYSTEM RELAY
CHARGE AIR OVERPRESSURE SWITCH
RADIO INTERFERENCE SUPPRESSION RELAY
BALLAST RESISTOR
FUEL INJECTOR

87866465

Fig. 150 Engine wiring — 1989 740 GL/GLE sedan and wagon (2.3L LH-Jetronic turbo)

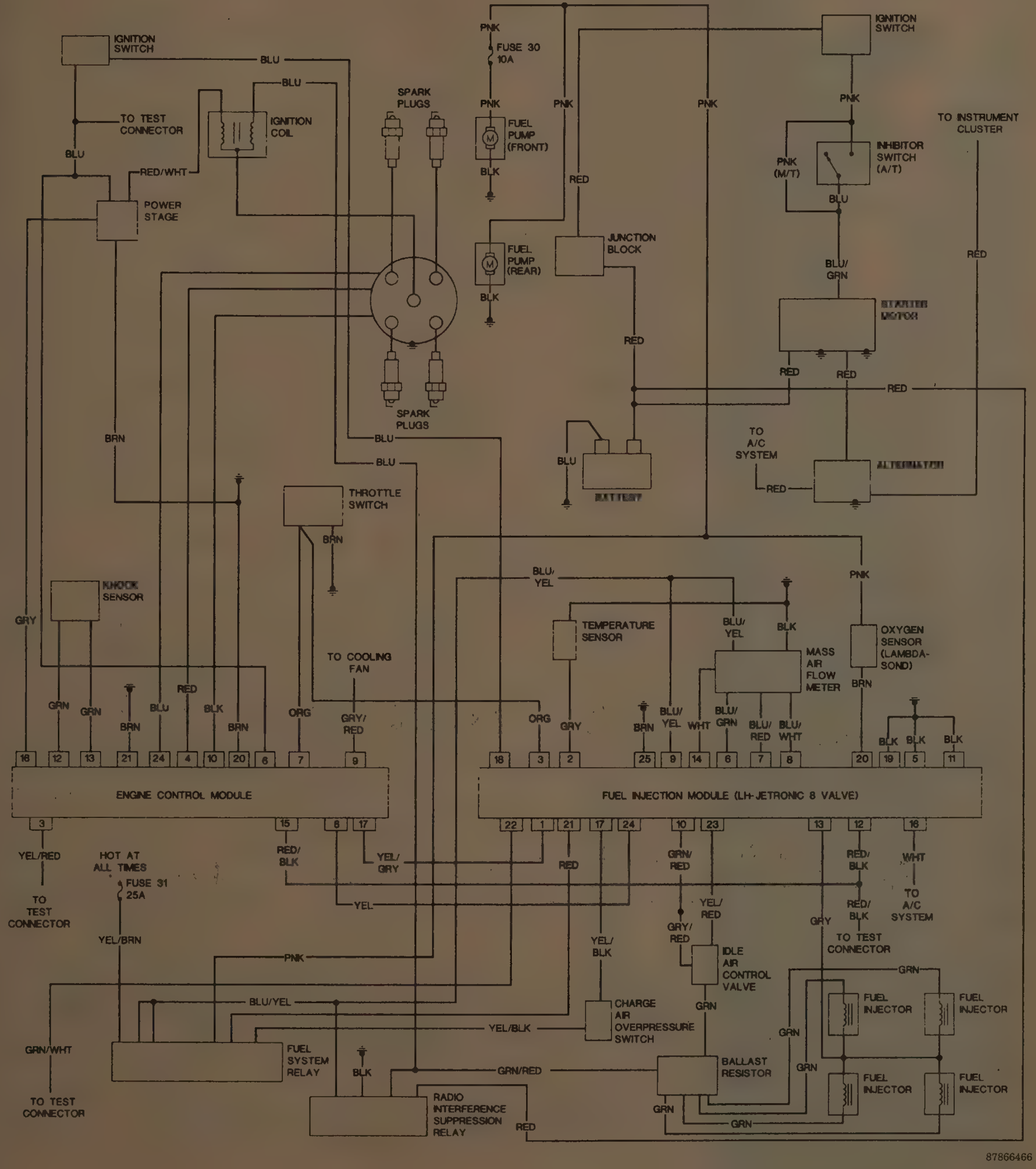

IGNITION SWITCH
BLU
TO TEST CONNECTOR
BLU
RED/WHT
IGNITION COIL
POWER STAGE
SPARK PLUGS
PNK
FUSE 30 10A
PNK
FUEL PUMP (FRONT)
BLK
PNK
PNK
RED
FUEL PUMP (REAR)
BLK
JUNCTION BLOCK
IGNITION SWITCH
PNK
PNK (M/T)
INHIBITOR SWITCH (A/T)
BLU
BLU/ GRN
TO INSTRUMENT CLUSTER
RED
STARTER MOTOR
RED
RED
RED
RED
SPARK PLUGS
BRN
BLU
BLU
BLU
BATTERY
TO A/C SYSTEM
RED
ALTERNATOR
THROTTLE SWITCH
BRN
KNOCK SENSOR
GRY
TO COOLING FAN
BLU/ YEL
TEMPERATURE SENSOR
BLU/ YEL
BLK
MASS AIR FLOW METER
PNK
OXYGEN SENSOR (LAMBDA-SOND)
BRN
GRN
GRN
BRN
BLU
RED
BLK
BRN
ORG
GRY/ RED
ORG
GRY
BRN
BLU/ YEL
WHT
BLU/ GRN
BLU/ RED
BLU/ WHT
BLK
BLK
BLK
18
12
13
21
24
4
10
20
6
7
9
18
3
2
25
9
14
6
7
8
20
19
5
11
ENGINE CONTROL MODULE
FUEL INJECTION MODULE (LH-JETRONIC 8 VALVE)
3
15
8
17
22
1
21
17
24
10
23
13
12
16
YEL/RED
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 31 25A
YEL/BRN
RED/ BLK
YEL/ GRY
YEL
RED
GRN/ RED
YEL/ RED
GRY/ RED
RED/ BLK
RED/ BLK
TO TEST CONNECTOR
WHT
TO A/C SYSTEM
GRY
IDLE AIR CONTROL VALVE
YEL/ BLK
PNK
BLU/YEL
CHARGE AIR OVERPRESSURE SWITCH
YEL/BLK
GRN
GRN
FUEL INJECTOR
FUEL INJECTOR
GRN/WHT
TO TEST CONNECTOR
FUEL SYSTEM RELAY
BLK
GRN/RED
BALLAST RESISTOR
GRN
GRN
FUEL INJECTOR
FUEL INJECTOR
RADIO INTERFERENCE SUPPRESSION RELAY
RED
GRN
GRN
87866466

Fig. 151 Engine wiring — 1989 760 sedan and wagon; 780 coupe (2.3L LH-Jetronic turbo)

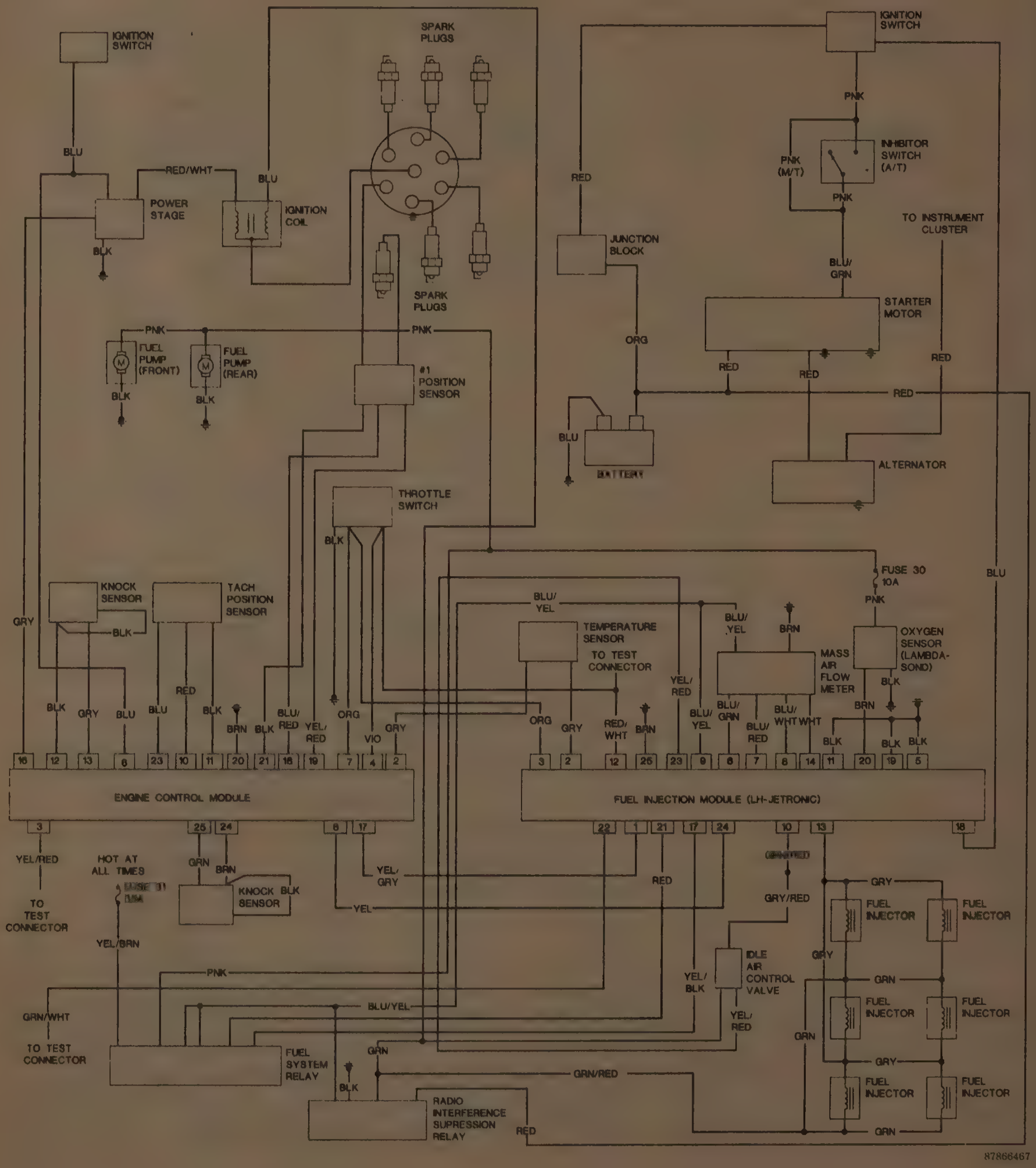

IGNITION SWITCH
SPARK PLUGS
IGNITION SWITCH
BLU
RED/WHT
POWER STAGE
BLK
IGNITION COIL
PNK
INHIBITOR SWITCH (A/T)
PNK (M/T)
RED
JUNCTION BLOCK
TO INSTRUMENT CLUSTER
BLU/GRN
STARTER MOTOR
ORG
FUEL PUMP (FRONT)
FUEL PUMP (REAR)
#1 POSITION SENSOR
BATTERY
ALTERNATOR
THROTTLE SWITCH
FUSE 30 10A
KNOCK SENSOR
TACH POSITION SENSOR
BLU/YEL
TEMPERATURE SENSOR
TO TEST CONNECTOR
MASS AIR FLOW METER
OXYGEN SENSOR (LAMBDA-SOND)
GRY
YEL/RED
ORG
VIO
RED/WHT
BRN
BLU/WHT
WHT
ENGINE CONTROL MODULE
FUEL INJECTION MODULE (LH-JETRONIC)
TO TEST CONNECTOR
HOT AT ALL TIMES
FUSE 11 15A
YEL/BRN
GRN
KNOCK SENSOR
YEL/GRY
YEL
GRY/RED
IDLE AIR CONTROL VALVE
YEL/BLK
FUEL INJECTOR
GRN/WHT
FUEL SYSTEM RELAY
GRN/RED
RADIO INTERFERENCE SUPRESSION RELAY
87866467

Fig. 152 Engine wiring — 1989 760 GLE sedan and wagon; 780 coupe (2.8L LH-Jetronic turbo)

7

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MANUAL TRANSMISSION

Basic Operating Principles

Because of the way an internal combustion engine breathes, it can produce torque, or twisting force, only within a narrow speed range. Most modern, overhead valve engines must turn at about 2500 rpm to produce their peak torque. By 4500 rpm they are producing so little torque that continued increases in engine speed produce no power increases.

The manual transmission and clutch are employed to vary the relationship between engine speed and the speed of the wheels so that adequate engine power can be produced under all circumstances. The clutch allows engine torque to be applied to the transmission input shaft gradually, due to mechanical slippage. The car can, consequently, be started smoothly from a full stop.

The transmission changes the ratio between the rotating speeds of the engine and the wheels by the use of gears. On cars, 4-speed or 5-speed transmissions are most common. The lower gears allow full engine power to be applied to the rear wheels during acceleration at low speeds.

The transmission contains a mainshaft which passes all the way through the transmission, from the clutch to the driveshaft. This shaft is separated at one point, so that front and rear portions can turn at different speeds.

Power is transmitted by a countershaft in the lower gears and reverse. The gears of the countershaft mesh with gears on the mainshaft, allowing power to be carried from one to the other. All the countershaft gears are integral with that shaft, while several of the mainshaft gears can either rotate independently of the shaft or be locked to it. Shifting from one gear to the next causes one of the gears to be freed from rotating with the shaft and locks another to it. Gears are locked and unlocked by internal dog clutches which slide between the center of the gear and the shaft. The forward gears usually employ synchronizers; friction members which smoothly bring gear and shaft to the same speed before the toothed dog clutches are engaged.

The clutch is operating properly if:

1. It will stall the engine when released with the vehicle held stationary.
2. The shift lever can be moved freely between 1st and reverse gears when the vehicle is stationary and the clutch disengaged.

Identification

See Figure 1

The transmission type, serial number and part number are stamped on a metal plate which is riveted to the underside of the case on manual transmissions or the left side on automatic transmissions.

Manual transmissions installed in 1970-89 Volvos are the M40/M41, M45/M46, M400/M410 and the M47 models. Except for the 5-speed M47 introduced in 1987, all are fully synchronized 4-speed transmissions with all forward gears in constant mesh. The M41, M46 and M410 units are equipped with Laycock-deNormanville overdrive units, and except for the overdrive engaging switch and push plate, are identical to their M40, M45 and M400 counterparts.

The M40 transmission is installed as standard equipment on 140 series and the 1975 240 series models. The M41 overdrive unit is optional on the 140 series and the 1975 240 series, and standard equipment on most 1800E and all 1800ES models. The M400 transmission is standard equipment on 164 models. The M410 overdrive unit is optional on 164 models, and was installed on some early 1970 1800E models. The M45 transmission is standard on 1976 and later 240 series models and the 1980 and later DL. The M46 overdrive unit is optional on 1976-80 240 models and the 1980 and later DL and standard on 260 series models and the 1980 and later GL, GLE, Diesel, GT Coupe and 760 GLE.

In 1982 the M46 became the standard the M46 became the standard unit for all models with manual transmission and in 1987 the 240, 740 and 760 Turbo received the 5-speed M47. The M47 continues through 1989 in the 240 series and the 740 Turbo. The 1989 740 GL uses the M46 transmission.

Adjustments

LINKAGE

See Figure 2

Shift linkage adjustments are neither necessary nor possible on Volvo manual transmissions. The linkage is mounted internally and is permanently bathed in oil.

On 1970-71 140 series, the shift lever mounts directly in the top of the transmission. This configuration, although providing for more direct shifting action, required the use of a long wand-like shift lever with long throws required to change gears. This situation was remedied on 1972 and later 140 series cars, as well as all 164 and 1800 series and all later models, with the implementation of an inboard mounted, intermediate

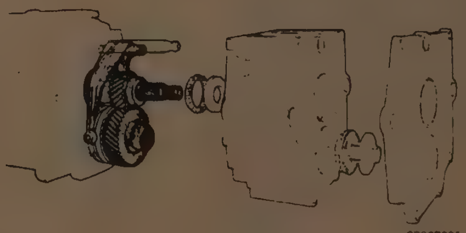


Fig. 1 The M47 transmission is essentially an M45 with a 5th gear

shifter rod. This rod allows the use of a much shorter, sportier shift lever and shorter throws between gears.

On these models the reverse gear detent clearance is the only adjustment that can be made to the shift linkage. When properly adjusted, first and second gears can be easily selected and the shift lever has about ½ inch of sideways freeplay in either gear.

Remove the shift lever cover, the trim frame and if necessary, the ash tray assembly. Engage first gear and adjust the clearance between the detent plate and the gear shift lever. Also check the clearance with second gear engaged. Clearance should be 0.02-0.06 in. (0.5-1.5mm).

Back-up Light Switch

REMOVAL & INSTALLATION

M45/M46 Transmissions Through 1984

➧ **See Figures 3 and 4**

1. Remove the gearshift boot. >Remove the gearshift boot. Remove the left side cover panel from the center console and disconnect the reverse light connector.
2. Bend a piece of stiff wire into a large "S" shape and slide it down the right side of the transmission tunnel. This will be used to keep the wire harness from vanishing into an impossible location.
3. Safely elevate the front of the car and support it on jackstands.
4. Gain access to the switch and disconnect the wiring.

To install:

5. Install the new switch and, using the S-hook, position the cable properly and resecure it to the gearshift carrier rod.
6. Lower the vehicle and attach the connector for the reverse lights.
7. Remove the S-hook, reinstall the left side panel on the console and the shift boot.

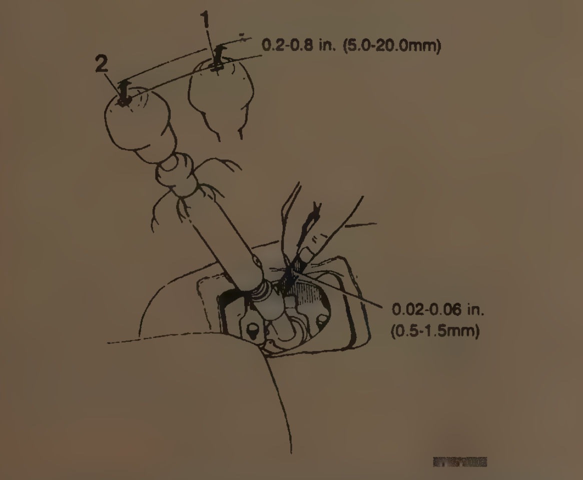


Fig. 2 Adjust the detent plate for the correct clearance

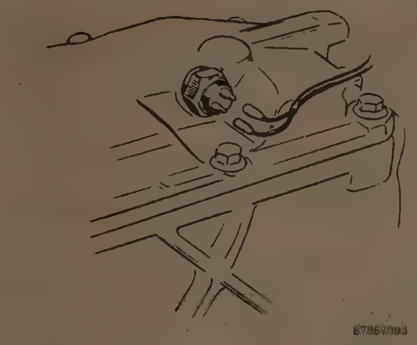


Fig. 3 Location of the back-up light switch on M45, M46 and M47 transmissions

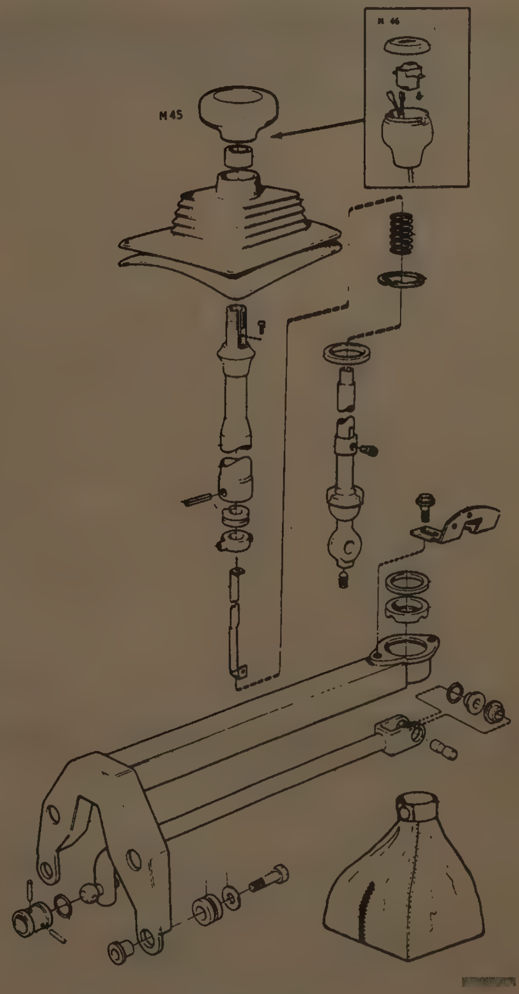


Fig. 4 Shift lever assemblies — M45 and M46 (see insert) transmission

700 Series With 4-Cylinder Engine

1. Elevate the car's front and rear, and safely support on jackstands.
2. Matchmark and remove the front driveshaft from the transmission or overdrive unit; lower the shaft out of the way.
3. Position and support the transmission with a jack or transmission hoist.
4. Loosen, but do not separate the exhaust joint at the right side of the transmission case.
5. Carefully remove the transmission crossmember from the body.
6. Lower the rear end of the gearbox.
7. Disconnect the wiring from the switch. Thoroughly clean the area around the switch before removing it.
8. After replacing the switch and connecting the wiring, check its function before reassembling everything.

To install:

9. Raise the gearbox back into position and install the crossmember. Position and tighten the exhaust joint.
10. Reinstall the driveshaft. Lower the car from its stands.

Transmission

REMOVAL & INSTALLATION

The transmission assembly may be removed with the engine installed in the vehicle.

140 Series and 1975 240 Series

1. If possible, support the engine with a hoist or support apparatus such as Volvo tool No. 2727. The purpose of supporting the rear of the engine is to prevent damage to the fan, radiator or front engine mounts by limiting the downward travel of the engine when the transmission crossmember is removed. If no lifting apparatus is available, place a jack with a protective wooden block beneath the engine oil pan. Do not place the jack under the flywheel (clutch) housing.
2. Lift up the gearshift boot, unscrew the protective cover, and remove the gear shift lever from the transmission.
3. Safely elevate the car at a height which will allow removal of the transmission. Remove the drain plug from the transmission and drain the oil.
4. Slowly loosen the nuts for the transmission crossmember. Make sure that the supporting apparatus or the jack supports the rear of the engine in place.Remove the crossmember. Disconnect the front universal joint from the transmission (or overdrive) output shaft flange. Disconnect the speedometer cable. Disconnect the rear engine mount and the exhaust pipe bracket.
5. Allow the rear of the engine to drop 0.8 in. (2mm). Disconnect the back-up light wires, and the wires for the overdrive, if so equipped.
6. Remove the four bolts which retain the transmission to the flywheel (clutch) housing. It may be necessary to use a universal (swivel) joint on the wrench to gain access to the two upper bolts.

✱✱WARNING

The transmission is heavy! Support its weight with a second jack or hoist before removing. Do not allow the transmission to hang partially removed on the shaft.

7. To remove the transmission, pull it straight out to the rear. While the transmission is removed, inspect the condition of the clutch and the throwout bearing. Replace the throwout bearing if it is scored or if it has been emitting metal-to-metal noises.

✱✱WARNING

The transmission is heavy! Support its weight with a second jack or hoist before removing. Do not allow the transmission to hang partially removed on the shaft.

To install:

8. When reinstalling, be careful to install two guide pins in the flywheel (clutch) housing. This will aid in aligning the transmission input shaft with the clutch spline when the transmission is being fitted to the flywheel housing. The transmission must be supported on the jack and pushed straight in to the clutch assembly. Again, do not allow the transmission to hang partially installed; the input shaft may bend.
9. Install two of the transmission retaining bolts. After two transmission-to-flywheel housing bolts are installed, the guide pins may be removed and the remaining two bolts installed. Torque the transmission-to-flywheel housing bolts to 45 ft. lbs. (61 Nm). Fill the transmission with oil to the proper level.
10. Reconnect the wiring for the overdrive unit and/or the reverse lights. Elevate the rear of the engine about 0.8 in. (2mm) until it is in its original position.
11. Reinstall the exhaust pipe bracket, the rear engine mount and reconnect the speedometer cable. Attach the driveshaft to the transmission or overdrive unit.
12. Reattach the support crossmember. Double check all installation items, paying particular attention to loose hoses or hanging wires, improperly tightened nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the work area.
13. Lower the car from its stands. Inside the car, reinstall the shift lever mechanism, the protective cover and the shifter boot.
14. Remove the hoist or support apparatus from the engine area.

164 Models

1. If possible, support the engine with a hoist or support apparatus such as Volvo tool No. 2727. The purpose of supporting the rear of the engine is to prevent damage to the fan, radiator, or front engine mounts by limiting the downward travel of the engine when the transmission crossmember is removed. If no lifting apparatus is available, place a jack with a protective wooden block beneath the engine oil pan. Do not place the jack under the flywheel (clutch) housing.
2. Lift up the gearshift boot, unscrew the protective cover, and remove the gear shift lever from the transmission.

3. Safely elevate the car at a height which will allow removal of the transmission. Remove the drain plug from the transmission and drain the oil.

4. Remove the upper radiator bolts and the exhaust manifold flange nuts. Disconnect the negative battery cable, the throttle shaft and clutch cable from the flywheel (clutch) housing.

5. Slowly loosen the nuts for the transmission support crossmember. Making sure that the rear of the engine remains supported, remove the crossmember.

6. Disconnect the exhaust pipe bracket and the speedometer cable. Disconnect the front universal joint from the transmission (or overdrive) output shaft flange.

7. Lower the rear of the engine approximately 1.8 in. (46mm). Disconnect the back-up light wires and the wires for the overdrive, if so equipped.

WARNING

The transmission is heavy. Support its weight with a second jack or hoist before removing. Do not allow the transmission to hang partially removed on the shaft.

8. Place a hydraulic floor jack beneath the transmission. Remove the bolts which retain the transmission and flywheel (clutch) housing assembly to the engine. Leave the starter connected but position it to one side. Remove the transmission by pulling it straight to the rear.

9. Prior to assembly, inspect the condition of the clutch and the throwout bearing. Replace the bearing if it is scored or noisy in operation.

10. When reassembling, do not allow the gearbox to hang on the shaft partially installed. Support the transmission on the jack and slide it straight forward into the flywheel assembly. Install the retaining bolts and torque them to 45 ft. lbs. (61 Nm).

11. Reattach the starter if necessary. Fill the transmission oil to the proper level. Reconnect the overdrive and/or reverse light wiring.

12. Elevate the rear of the engine until it is in its original position.

13. Reinstall the exhaust pipe bracket and reconnect the speedometer cable. Attach the driveshaft to the transmission or overdrive unit.

14. Reattach the support crossmember. Reconnect the clutch cable, the throttle shaft and the negative battery cable.

15. Replace the upper radiator bolts and the exhaust manifold flange nuts. Double check all installation items, paying particular attention to loose hoses or hanging wires, improperly tightened nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the work area.

16. Lower the car from its stands. Inside the car, reinstall the shift lever mechanism, the protective cover and the shifter boot.

17. Remove the hoist or support apparatus from the engine area.

1800 Series

WITH M41 TRANSMISSION

1. Remove the storage console from the transmission tunnel. Lift up the shifter boot, unscrew the protective cover and remove the gear shift lever.

2. Disconnect the negative battery cable. Remove the radiator attaching bolts.

3. Jack up the vehicle sufficiently to allow removal of the transmission. Install jackstands. Remove the lower drain plug and drain the transmission oil.

4. Remove the bolts which retain the driveshaft to the flange, and remove the attaching bolts for the support bearings. Pull the driveshaft approximately ½ in. (13mm) to the rear.

5. Place a jack, with a protective wooden block, beneath the oil pan of the engine.

6. Disconnect the exhaust pipe bracket and the speedometer. Remove the rear engine mount. Slowly loosen the nuts for the transmission support crossmember making sure that the jack supports the rear of the engine.

7. Lower the engine approximately 0.8 in. (2mm). Disconnect the electric cables from the transmission.

WARNING

The transmission is heavy. Support its weight with a second jack or hoist before removing. Do not allow the transmission to hang partially removed on the shaft.

8. Remove the four bolts which secure the transmission to the flywheel (clutch) housing. It may be necessary to use a universal joint to gain access to the two upper bolts. Support the weight of the transmission with another jack and pull the unit straight out to the rear.

9. To remove the transmission, pull it straight out to the rear. While the transmission is removed, inspect the condition of the clutch and the throwout bearing. Replace the throwout bearing if it is scored or if it has been emitting metal-to-metal noises.

10. When reinstalling, be careful to install two guide pins in the flywheel (clutch) housing. This will aid in aligning the transmission input shaft with the clutch spline when the transmission is being fitted to the flywheel housing. The transmission must be supported on the jack and pushed straight in to the clutch assembly. Again, do not allow the transmission to hang partially installed; the input shaft may bend.

11. Install two of the transmission retaining bolts. After two transmission-to-flywheel housing bolts are installed, the guide pins may be removed and the remaining two bolts installed. Torque the transmission-to-flywheel housing bolts to 45 ft. lbs. (61 Nm). Fill the transmission with oil to the proper level.

12. Reconnect the wiring for the overdrive unit and/or the reverse lights. Elevate the rear of the engine about 0.8 in. (2mm) until it is in its original position.

13. Reinstall the exhaust pipe bracket, the rear engine mount and reconnect the speedometer cable. Attach the driveshaft to the transmission or overdrive unit.

14. Reattach the support crossmember. Double check all installation items, paying particular attention to loose hoses or hanging wires, improperly tightened nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the work area.

15. Lower the car from its stands. Inside the car, reinstall the shift lever mechanism, the protective cover and the shifter boot.

16. Reinstall the radiator attaching bolts and connect the negative battery cable.

WITH M410 TRANSMISSION

1. Disconnect the upper and lower radiator hoses and drain the cooling system. Disconnect the heater hoses and the air intake hose. Pull up the rubber boot, unscrew the protective cover and remove the gearshift lever.
2. Raise the vehicle sufficiently to remove the transmission, and install jackstands. Disconnect the driveshaft, exhaust pipe bracket, clutch cable, and the electrical wires for the backup light and the overdrive.
3. Place a hydraulic floor jack beneath the transmission, and remove the transmission support crossmember.
4. Place a protective wooden block between the rear of the engine and the firewall. Lower the jack and the rear of the engine until the engine contacts the wooden block.

****WARNING**

The transmission is heavy! Support its weight with a second jack or hoist before removing. Do not allow the transmission to hang partially removed on the shaft.

5. Remove the bolts which secure the flywheel (clutch) housing to the engine. Leave the starter connected but position it to one side. Remove the transmission by pulling it straight to the rear.
6. Prior to installation, inspect the condition of the clutch and throwout bearing. Replace the bearing if it is scored or has been noisy in operation.
7. After reinstalling the transmission, tighten the mounting bolts to 45 ft. lbs. (61 Nm). Secure the starter to the bellhousing. Fill the transmission with oil to the proper level.
8. Raise the motor to its proper position and support it on the jack until the transmission crossmember is in place. Once secure, remove the block of wood from the firewall area.
9. Reattach the driveshaft, the exhaust pipe bracket, the clutch cable and the wiring for the overdrive and the reverse lights.
10. Double check all installation items, paying particular attention to loose hoses or hanging wires, improperly tightened nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the work area. Lower the vehicle to the ground.
11. Reinstall the heater hoses, the air intake and the upper and lower radiator hoses. Fill the cooling system with the proper amount of fluid.
12. Inside the car, install the shifter mechanism, the protective cover and the shift boot.

1976 and Later 200 Series without M46 or M47

1. Disconnect the battery. At the firewall, disconnect the back-up light connector.
2. Jack up the front of the car and install jackstands. Under the car, loosen the setscrew and drive out the pin for the shifter rod. Disconnect the shift lever from the rod.
3. Inside the car, pull up the shift boot. Remove the fork for the reverse gear detent. Remove the snapring and lift up the shifter. If overdrive-equipped, disconnect the engaging switch wire.
4. On 240 Series and 1980 and later GL and DL models, disconnect the clutch cable and return spring at the fork. On 260 Series and 1980 and later GLE, Diesel, GT and Coupe models, remove the bolts retaining the slave cylinder to the flywheel housing and tie the cylinder back out of the way (do not disconnect any hoses).
5. Disconnect the exhaust pipe bracket(s) from the flywheel cover. Remove the oil pan splash guard.
6. Using a floor jack and a block of wood, support the engine beneath the oil pan. Remove the transmission support crossmember.
7. Disconnect the driveshaft. Disconnect the speedometer cable. If so equipped, disconnect the overdrive wire.
8. Remove the starter retaining bolts and pull the starter free of the flywheel housing. Leave the starter wiring connected and secure the starter out of the way.

****WARNING**

The transmission is heavy. Support its weight with a second jack or hoist before removing. Do not allow the transmission to hang partially removed on the shaft.

9. Support the transmission using another floor jack. Remove the flywheel (bell) housing-to-engine bolts and remove the transmission by pulling it straight back.
10. Inspect the condition of the clutch and throwout bearing. Replace the bearing if it is scored or has been noisy in operation.
11. After reinstalling the transmission, tighten the mounting bolts to 30 ft. lbs. (41 Nm). Secure the starter to the bellhousing. Fill the transmission with oil to the proper level.
12. Connect the drive shaft, the speedometer cable and if necessary, the overdrive wiring.
13. Reinstall the transmission cross member. When secure, remove the jack from beneath the engine. Replace the splash guard and attach the exhaust bracket to the bell housing.
14. Depending on the model, either reconnect the clutch cable and return spring to the fork or remount the hydraulic clutch cylinder to the bell housing.
15. Inside the car, connect the shifter and the reverse gear detent fork. Connect the wiring for the overdrive switch and install the shift boot and cover.
16. Under the car, connect the shifter rod to the shift lever. Don't forget to tighten the setscrew.
17. Connect the reverse light wiring and attach the negative battery cable.

700 Series and 1976 and Later 200 Series with M46 or M47

➧ See Figures 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18

1. If possible, support the engine with a hoist or support apparatus such as Volvo tool No. 5006. The purpose of supporting the rear of the engine is to prevent damage to the fan, radiator or front engine mounts by limiting the downward travel of the engine when the transmission crossmember is removed. If no lifting apparatus is available, place a jack with a protective wooden block beneath the engine oil pan. Do not place the jack under the flywheel (clutch) housing.
2. Disconnect the battery ground cable.

3. Remove the ash tray and holder assembly. Remove the trim box around the gear shift lever.

4. Disconnect the shift lever cover from the floor. Remove the snapring at the base of the shift lever.

5. Jack up the car and safely support it with jackstands. From underneath the car, disconnect the gear shift rod at the gear shift lever. Remove the lock screw, and press out the pivot pin. Push up on the shift lever, and pull it up and out of the car.

6. Matchmark the driveshaft and transmission flanges for later assembly. Disconnect the driveshaft from the transmission.

7. Separate the exhaust pipe at the joint under the car. Detach the bracket from the front end of the exhaust pipe (near the bend).

8. Unbolt the transmission crossmember; at the same time, detach it from the rear support (rubber bushing).

9. Remove the rear support from the transmission.

➡On B200 and B230 engines, lower the engine until ½ inch remains between the distributor cap and the firewall.

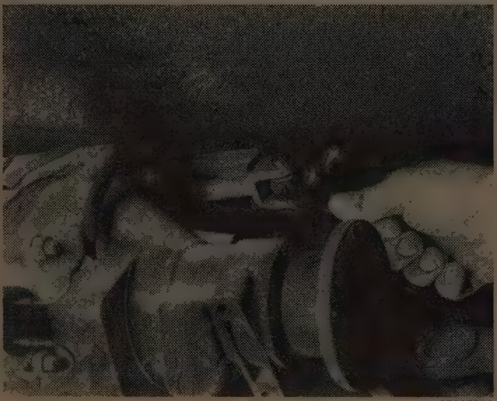


Fig. 5 Remove the (Allen) lock screw retaining the shift rod pivot pin (note the driveshaft has already been disconnected in this photo)

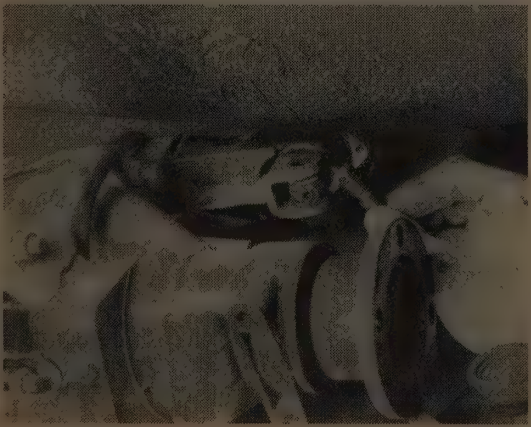


Fig. 6 Use a punch to push out the pin and release the shift rod

Fig. 7 Use the correct metric socket to unbolt the transmission crossmember

Fig. 8 Remove the rear support from the transmission (note the exhaust is still in place)

10. Tag and disengage the electrical connectors from the overdrive, back-up light connector and the solenoid.

11. Cut the plastic clamp at the gear shift assembly from the wiring harness.

12. Remove the starter motor retaining bolts. On models with the B28 family of V6 engines, remove the cover plate under the bellhousing and the cover plate from the other starter motor opening.

13. On B28F models (hydraulic clutch), remove the slave cylinder from the bellhousing and upper bolts holding the bellhousing. On D24T models, (mechanical clutch), detach the clutch cable from the release fork and the bellhousing. Remove the upper retaining bolts from the bell housing.

⁂WARNING

The transmission is heavy. Support its weight with a second jack

Fig. 9 Tag and disengage the electrical connectors from the overdrive, back-up light connector and the solenoid (shown)

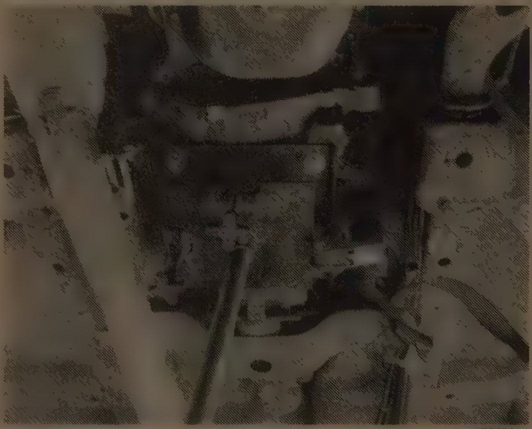


Fig. 10 Use a suitable transmission or floor jack to support the transmission while you are working

14. Remove the clutch cable from the release fork and the bellhousing. Remove the upper retaining bolts from the bell housing.

✻✻WARNING

The transmission is heavy. Support its weight with a second jack or hoist before removing. Do not allow the transmission to hang partially removed on the shaft.

15. Place a transmission jack or a hydraulic floor jack underneath the gearbox so that the transmission is resting on the jack pad.

➡It is very helpful to have another person steadying and guiding the transmission on the jack as it is lowered.

16. Remove the lower bolts holding the bellhousing, and carefully lower the transmission a few inches as you roll it back so the input shaft will clear.

Fig. 11 Remove the retaining clip to release the clutch cable (it may be necessary to loosen the adjuster first)

Fig. 12 Remove the clutch cable end from its seat, then support it out of the way of the transmission

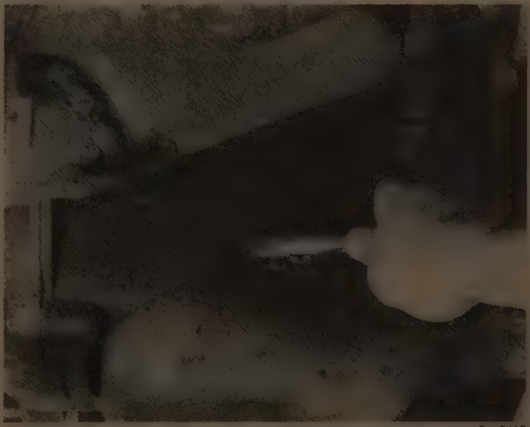


Fig. 13 Remove all the lower bolts holding the bellhousing

17. Stop the jack and make sure all wires and linkage are disconnected, then lower the transmission the rest of the way.

To install:

18. When sliding the transmission into place, make sure the release bearing is correctly positioned in the shift fork, and that the input shaft is aligned in the clutch disc.
19. Install the upper bolts in the bellhousing. Raise the end of the gearbox and attach the gear carrier lever.
20. Attach the slave cylinder or clutch cable to its mounts. Adjust clutch clearance on D24T models to 0.04-0.12 in. (1-3mm) between the release fork and bearing.
21. Reinstall the starter motor. On B28 engines, reinstall the cover for the other starter hole.
22. Remount the gear lever carrier to the gearbox. Secure the connectors for the reverse lights, the solenoid and (on M46) the overdrive unit.
23. Replace the transmission crossmember. On B200/B230 engines, elevate the motor back to its normal position.

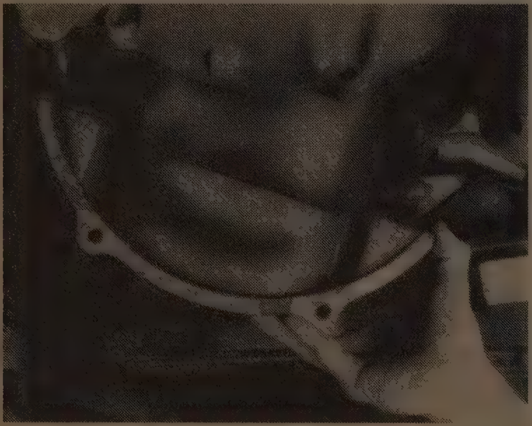


Fig. 14 Remove this cast cover when ready to separate the transmission

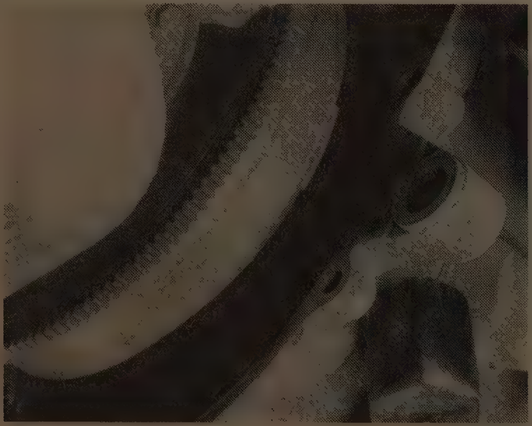


Fig. 15 Take care as you lower the transmission just a few inches, then roll it back so the input shaft will clear

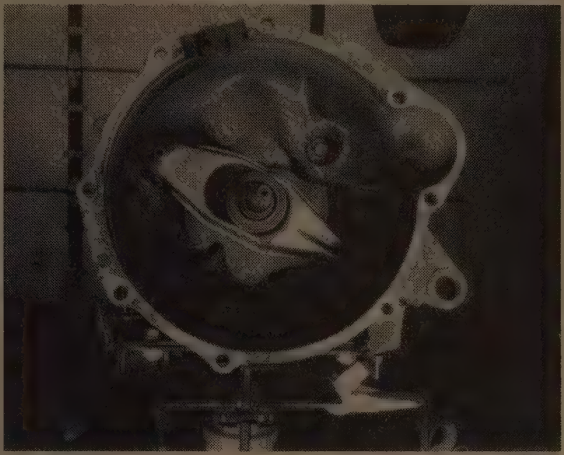


Fig. 16 Lower the transmission on the jack

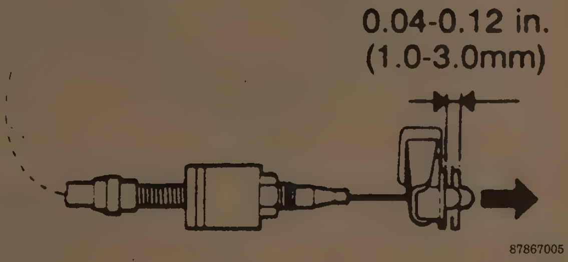


Fig. 17 Adjust the clutch cable for proper operation

24. Tighten the exhaust pipe joint, attach its bracket and attach the gearshift rod to the gearshift lever.
25. Install and tighten the driveshaft. Refill the transmission with the proper amount of oil.
26. Connect the gearshift rod to the gear shift lever. Inside the car, mount and secure the shifter assembly.
27. Double check all installation items, paying particular attention to loose hoses or hanging wires, improperly tightened nuts, poor routing of hoses and wires (too tight or rubbing) and tools left in the work area.
28. Lower the car to the ground. Install the ashtray, interior trim and shifter boot.
29. Reconnect the negative battery cable.

OVERHAUL

The procedures below refer to a manual gearbox which is removed from the car. If the unit has been removed with the

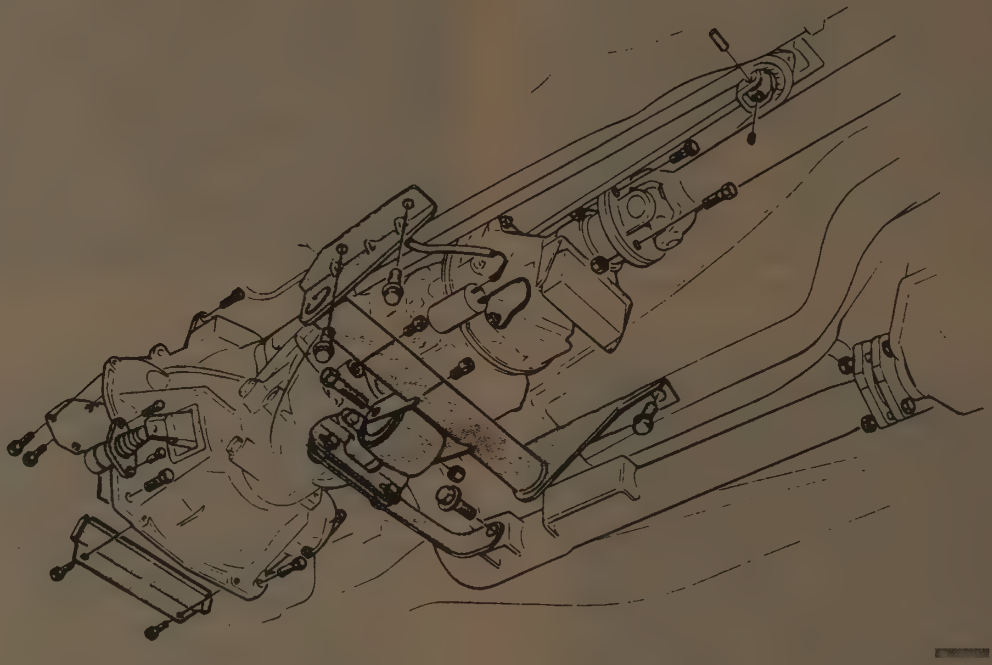


Fig. 18 Fasteners crucial to the transmission assembly and mounting — 700 series

overdrive attached, remove the overdrive unit before carrying out these procedures.

✻✻WARNING

The use of the correct special tools or their equivalent is REQUIRED for this procedure. Do not begin repairs unless equipped with bearing pullers, hub pullers, snapring pliers, and variously sized bearing drivers and installation tools. Access to a press will also be required.

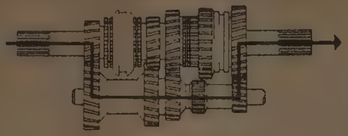
M40/M41 Transmissions

▶ See Figures 19, 20, 21, 22 and 23

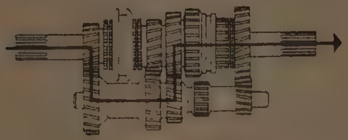
1. Mount the gearbox securely on the workbench or attach to a transmission stand.
2. Unscrew the bolts for the gearbox cover and remove the cover. Remove the spring and interlock (detent) balls for the shift rails.
3. Remove the cover over the shift rails and remove the selector fork bolts.
4. Slide the selector fork backwards to the 1st gear position. Drive the retaining pin out slightly, but do not allow it to foul the 1st gear. Move the selector fork forward enough to allow the pin to pass in front of the gear. Drive the pin out completely and remove it.
5. Slide out the selector rails. Hold the forks so that they maintain position and do not jam the rails. Remove the forks.
6. Remove the bolts for the rear cover. Turn the cover so that it does not lock the shaft for the idler and reverse gears. Drive out the shaft for the idler gear. The idler gear will fall to the bottom of the gearbox.

➡The shaft must be driven out rearward.

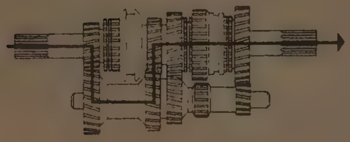
7. Pull out the mainshaft.
8. Remove the bolts and remove the cover over the input shaft. Gently pry out the oil seal from the cover.
9. Drive out the input shaft. It may be necessary to remove the circlip and press the bearing off the shaft.
10. Remove the idler gear from the bottom of the case. Using a puller of the correct size (Volvo No. 2878 or similar),



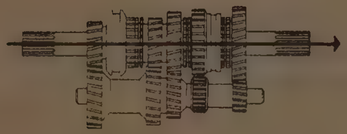
POWER PATH 1ST SPEED



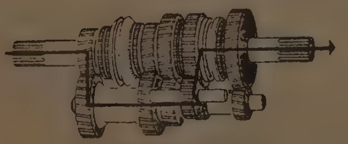
POWER PATH 2ND SPEED



POWER PATH 3RD SPEED



POWER PATH 4TH SPEED



POWER PATH REVERSE

87867008

Fig. 19 For each shift position, the line shows the direction of the engine's power through the gear clusters

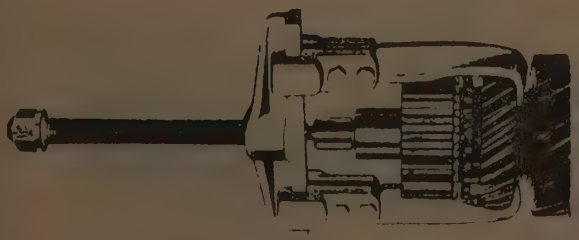


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Fig. 20 Use a gear puller to remove the front synchronizer — M40/M41 transmissions

remove the shaft for the reverse gear. When the shaft is free, remove the reverse gear and other parts from the case.

11. Disassemble the mainshaft as follows:
    a. If the transmission is equipped with overdrive, remove the circlip and press off the rotor for the overdrive oil pump. Remove the circlip for the mainshaft rear bearing. If not equipped with overdrive, counterhold the end flange and remove the flange nut.
    b. Slide the engaging sleeve for 1st and 2nd gear forward. Place the shaft in a press and support it under 1st gear. Press out the shaft.
    c. Remove the synchronizer, thrust washer, engaging sleeves, inserts and springs from the shaft. Take note of the order of assembly of the parts; make notes or diagrams to help you during reassembly.
    d. Remove the snapring on the front of the shaft. Pull off the synchronizer hub and 3rd gear using a puller. Remove the thrust washer.
    e. Remove the snapring, the thrust washer, 2nd gear, the synchronizer and spring.

f. Remove the oil seal from the rear cover and remove the speedometer gear. It may be necessary to remove the snaprings and press out the bearing.

12. When disassembled check each gear carefully, looking for any signs of cracking or chipping particularly in the tooth areas. ANY sign of damage requires replacement of the gear. Check the synchronizers and selector sleeves for excessive blunting of points or edges. Inspect all the bearings for scoring or cracks on the balls or races. Inspect the shift rails for excessive wear at the indentations.

To install:

13. Reassemble the mainshaft. Press the bearing into the rear cover and fit the snapring. Use a snapring which fits securely into the groove; select a different thickness if the ring is loose in fit.

14. For a gearbox without overdrive:

a. Place the speedometer gear on the bearing in the rear cover. Use a drift of the proper size and press in the oil seal.

b. Install the parts for the 1st and 2nd gear synchronizer on the mainshaft. Make sure the springs are installed correctly.

c. Install the synchronizer, 1st gear and the thrust washer. Place the rear cover on the shaft. Make sure that the speedometer gear is properly positioned.

d. Fit on the flange and use a sleeve to press on the cover and the flange. Using a counter hold on the flange, install the washer and nut for the flange and tighten the nut.

15. For a gearbox with overdrive:

a. Place the rear cover and bearing on a supporting sleeve. Install the thrust washer, 1st gear and synchronizer.

b. Press in the shaft. Select a snapring of the proper thickness and install it on the shaft.

c. Install the locking key, the rotor for the oil pump and the snapring.

16. Install the synchronizer, 2nd gear and thrust washer onto the shaft. Again, select a circlip which fits snugly in the groove and install it.

17. Install the thrust washer, 3rd gear and synchronizer on the shaft. Assemble the 3-4 synchronizer hub and install the snaprings. Install the synchronizer assembly on the mainshaft and select a snug fitting lockring to hold it in place.

18. After the mainshaft is assembled, install the reverse gear and shaft. The reverse shaft is mounted so that it projects 9/32 in. (7mm) outside the transmission case.

19. Using a mandrel of the proper size (Volvo No. 2907 or similar), place the spacing washers and needles (24 in each bearing) in position. Use grease to hold the needles in position.

20. Using grease to hold them in place, attach the washers to the housing and guide them into position. (A centering plug such as Volvo No. 2908 is very helpful here.) Lay the idler gear in the bottom of the gear housing.

21. Using a drift, press the bearing onto the input shaft. Lock it in place with a snapring. Again using grease to hold them in place, position the 14 bearing rollers in position in the input shaft. Press the input shaft into position in the housing and then press the oil seal into the cover.

22. Place the cover over the input shaft. Don't forget the O-rings for the bolts.

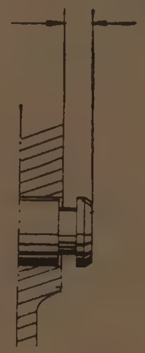


Fig. 22 The reverse shaft will project beyond the case. The dimension shown is 9/32 in. (7mm)

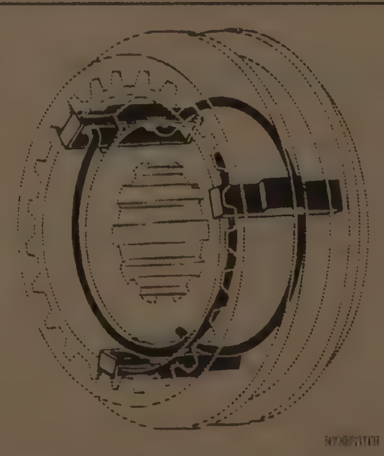
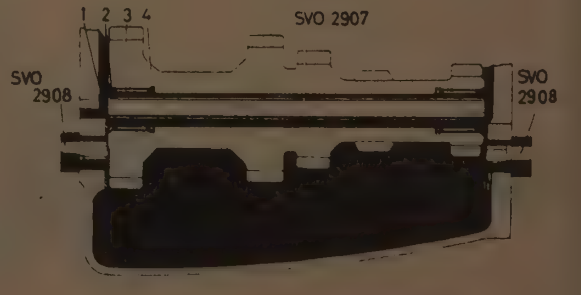


Fig. 21 Install the synchronizer springs in the correct position upon reassembly — M40/M41 transmissions



1. Thrust washer
2. Spacing washer
3. Needle bearing
4. Spacing washer

Fig. 23 Use a centering plug to install the idler gear — M40/M41 transmission. Volvo special tools shown

23. Place the mainshaft within the case. Turn the rear cover so that the counter shaft can be installed.
24. Gently turn the transmission upside down. Install the counter shaft from the rear and hold against the mandrel with your hand. Make sure the thrust washers (held in place by the grease) don't fall out of place. Install the idler gear.
25. If the transmission does not couple to an overdrive unit, install the rear cover. If an overdrive unit is used, install it with new hardware.
26. Reinstall the shift rails and forks. Move the selector fork over the rear position when installing the new lock pin. Install the cover over the shift rails.

➡If the end caps at the front of the case were removed, they should be reinstalled. Note that the center cap should project about 0.16 in (4mm) beyond the housing.

27. Install the interlock balls and springs. Install the gearbox cover.
28. Check the operation of the gearbox by testing each gear for smooth engagement and release.

M400/M410 Transmissions

➧ See Figures 24, 25, 26 and 27

1. Mount the gearbox securely on the workbench or attach to a transmission stand.
2. Unscrew the bolts for the gearbox cover and remove the cover. Remove the spring and interlock (detent) balls for the shift forks.
3. Remove the bolts for the selector forks. Push the rails backwards and drive out the tensioning pin in the flange of the rails.
4. Hold the selector forks so they don't jam on the rails and remove the rails. Remove the selector forks.
5. Install a counterhold (Volvo No. 2985 or similar) between the input shaft and the front synchronizer. Remove the bolt and remove the mainshaft rear bearing
6. Remove the release bearing. Loosen the bolts and remove the cover for the input shaft. Then remove the bolts for the clutch casing and remove the casing.
7. Remove the circlip and, using a bearing puller (Volvo No. 2982 or similar), remove the bearing for the input shaft. Remove the counterhold device.
8. Turn the transmission upside down. Using a metal drift placed in the center hole, carefully drive the intermediate shaft forward until the front gear just touches the end of the housing. Now drive the intermediate shaft backwards until the rear bearing outer ring releases.

➡The intermediate shaft may snag on the fitting for the reverse shaft. It may be necessary to guide the shaft to one side.

9. Place the transmission in its normal upright position. Pull out the input shaft and remove the synchronizer. Remove the thrust washer from the rear end of the mainshaft. Fit a lifting tool (Volvo No. 2829 or similar) onto the mainshaft. Push the 1st-2nd engaging sleeve backwards and lift the mainshaft clear of the case.
10. Lift the intermediate shaft. Using an appropriate drift, drive the outer ring for the intermediate shaft front bearing out of its mount. Pull off the inner rings — front and rear — with the appropriate pullers.
11. Using Volvo puller No. 2830 or similar, remove the reverse shaft and take out the reverse gear.
12. Drive out the sealing ring from the front and rear covers with a drift.
13. To disassemble the mainshaft:
    a. Remove the lifting tool and then remove 1st gear, the needle bearing and the synchronizer.
    b. Remove the engaging sleeves for the synchronizers. Remove the circlips for the synchronizer hubs.
    c. Place the shaft in a press and support it below the gears. Press off 2nd gear and the 1st-2nd synchronizing hub.
    d. Reverse the shaft and again place it in the press, supported below the gear. Press off 3rd gear and the 3rd-4th synchronizer hub.
14. After the shaft is disassembled, clean all the parts in solvent. Examine the gears carefully for any signs of cracks or scoring, particularly in the tooth areas. Check the synchroniz-

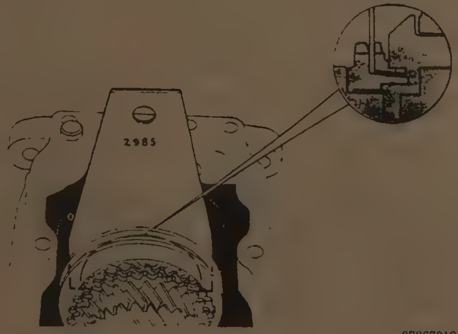


Fig. 24 Use Volvo special tool 2985, or similar, to counterhold the mainshaft between the input shaft and front synchronizer

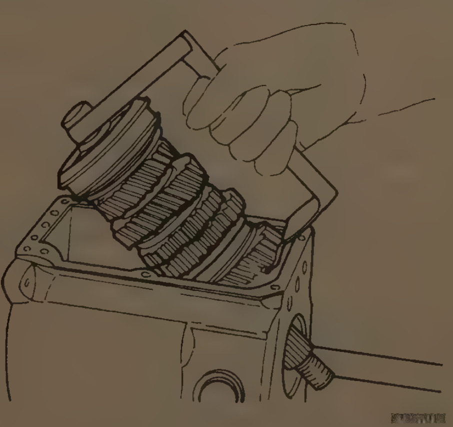


Fig. 25 Use this Volvo tool to remove and carry the mainshaft assembly

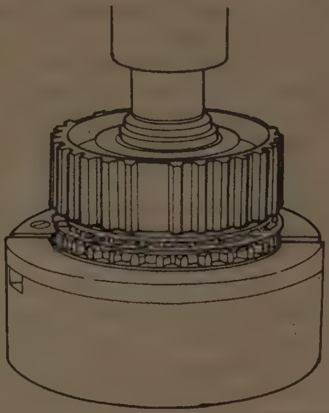


Fig. 26 Use a press to disassemble the mainshaft — Volvo tool shown

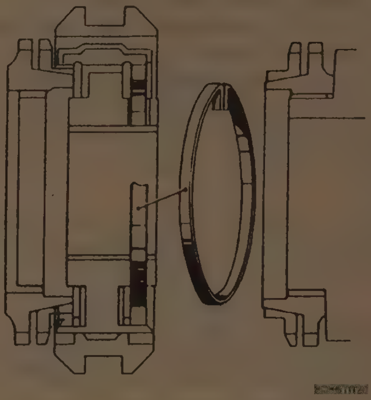


Fig. 27 Turn the gear to help make the flanges of the resilient ring fit correctly

ers for excessive wear, and examine the bearings closely for any sign of scoring or cracks.

15. To rebuild the mainshaft:
    a. Assemble the 1st-2nd and 3rd-4th synchronizers. Fit the snaprings correctly and place the resilient ring in the hub for the 3rd-4th synchronizer.
    b. Use a small screwdriver to center the ring and install the cone into the synchronizer. Make sure the flanges fit properly into the grooves. Assemble the complete synchronizer and 3rd gear. Turning the gear will make it easier to fit the resilient ring in place.
    c. Support the synchronizer and gear on a press. Insert the needle bearing and press in the mainshaft. Turn the gear during installation to check that the gear and needle bearing fit correctly. Select a circlip which is snug in the groove and install it.
    d. Assemble the 1st-2nd synchronizer, cone, 2nd gear and needle bearing on the press. Make sure the gear ring on the engaging sleeve faces forward and that the flanges fit correctly within the grooves of the cone. Press in the mainshaft. While installing, turn 2nd gear to prevent binding. Select a circlip which is snug in the groove and install it.
    e. Install 1st gear with its needle bearing and synchronizer onto the mainshaft. Install the lifting device.
16. Using appropriate drifts, install the sealing rings into the front cover. Press the bearing onto the input shaft. Note that the ball holder should face inwards. Press the rear bearing inner ring onto the intermediate shaft.
17. Place the gear lever for the reverse shaft onto the bearing pin in the transmission housing. Install the reverse gear and shaft. The shaft should be level with the housing or a maximum of 0.08 in. (2mm) underneath.
18. Place the intermediate shaft in the bottom of the case. Install the mainshaft in the case; remove the lifting tool and fit the thrust washers onto the mainshaft.
19. Install the rear bearing onto the mainshaft. The ball holder should face inwards. Using a bearing press, set the bearing into the housing.
20. Install the needle bearing on the input shaft. Install the loose cone for the 3rd-4th synchronizer. Place it correctly so that the flanges fit into the grooves. Push the input shaft into the housing and onto the pin of the mainshaft.
21. Turn the transmission upside down. Press the front bearing inner ring onto the intermediate shaft with suitable bearing drivers. Drive in the outer rings until they are about 0.10 in. (2.5mm) above the face of the case.
22. Turn the transmission so that the front end is up and install the clutch casing and the front cover with new gaskets.
23. Turn the transmission so that the rear end is upward. Install the new gasket and place a 0.028 in. (0.7mm) shim on the rear bearing outer ring. Using either a dial indicator or other accurate means, determine the amount of vertical play (axial) in the intermediate shaft. If using the dial indicator, press down on the center of the shaft and turn it; set the dial to zero when the shaft is at its lowest point. Press the intermediate shaft upwards (a small screwdriver through the oil level hole does this easily) and turn it. Record the dial reading when the shaft is at its highest point.
24. Subtract 0.0024 in. (0.06mm) from the highest reading and select shims equal to this difference. Remove the measuring equipment and insert the shims; the thickest shim should be against the rear cover. Recheck the end play; final measurements should be 0.0012-0.004 in. (0.03-0.10mm).
25. Reinstall the selector forks, flanges and selector rails. Make sure the flange for the reverse gear fits properly in the gear lever. Install the retaining bolts and install new tensioning pins.
26. Install the intermediate flange and a new gasket. Install the overdrive unit if so equipped.
27. Place the interlocking balls and springs in position. Install the transmission cover with a new gasket. Install the speedometer gear and the clutch release bearing.
28. Check the operation of the gearbox by testing each gear for smooth engagement and release.

M45/M46 and M47 Transmissions

➧ See Figures 28, 29, 30, 31, 32, 33, 34, 35 and 36

1. Mount the gearbox securely on the workbench or attach to a transmission stand.
2. Unscrew the bolts for the gearbox cover and remove the cover. Remove the spring and interlock (detent) ball for the

shift forks. Remove the reverse light switch and the overdrive switch (except M47).

3. Remove the selector plate assembly and the return spring. Remove the gasket and clean the gasket surface.

4. Remove the glide washers for the selector plate assembly. Remove the locking pin for the shifter.

5. On M46 units, remove the overdrive unit.

6. Remove the gearshift carrier assembly.

7. Remove the sleeve for the gearshift rod joint. Tap out the rear pin in the gearshift rod, rotate the rod and remove the front pin. Remove the gearshift rod.

8. Unbolt and remove the intermediate housing; remove the gasket and shims.

9. Remove the gear selector rails, the shifter and the shift forks.

10. On M46 units, remove the eccentric for the overdrive oil pump by removing the lock ring and pulling off the eccentric. Catch the locking key as it falls clear.

11. Remove the lock ring and spacer for the mainshaft bearing.

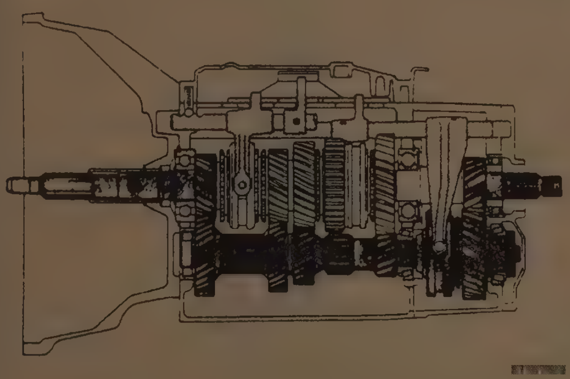


Fig. 28 Cutaway view of the M47 transmission — shown is power transfer in 5th gear

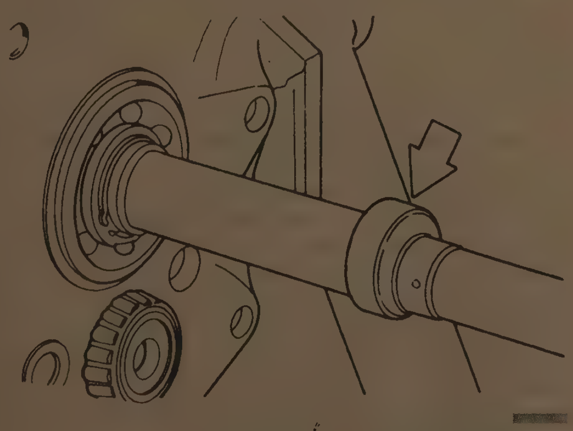


Fig. 29 Eccentric for the overdrive oil pimp — Be sure to catch the small locking pin during removal

12. Install a counterhold (Volvo No. 2985 or similar) between the input shaft and the front synchronizer. Remove the spacer ring and remove the mainshaft bearing. Remove the bearing thrust washer.

13. Remove the clutch fork, spacer and release bearing. Then remove the bolts for the clutch casing (bell housing) and remove the casing.

14. Remove the outer races for the intermediate shaft bearings. On cast iron housings, tap the shaft backwards until the rear outer bearing race comes free. Then knock the shaft forward until the front outer race can be removed. On aluminum cases (How can you tell? Use a magnet!) tap the shaft only enough to expose the race, then affix a puller (Volvo No. 5177 or similar) and extract the race. Continued thumping on the shaft will crack the case. Don't risk it.

15. Pull out the input shaft and remove the 4th gear synchronizer ring.

16. Lift out the main shaft.

17. Lift out the intermediate shaft, and on M47 units, the intermediate shaft extension.

18. Using a punch, tap the reverse gear shaft backwards and remove the gear and shaft.

19. Remove the reverse gear shift fork and remove the seal for the selector rail.

20. Using a suitable puller, remove the intermediate shaft bearings from the shaft.

21. Remove 1st gear and its synchronizer ring from the mainshaft.

22. Remove the lock ring for the 1st-2nd synchronizer hub. Using a press, support the hub and press the hub and gear off the shaft.

23. Remove the lock ring for the 3rd-4th synchronizer hub. Using a press, support the hub and press the hub and gear off the shaft. On M47 units, remove the 5th gear synchronizer, hub and gear.

24. Remove the locking ring and spacer ring for the input shaft bearing.

25. Again using the press and supporting the bearing, remove the bearing on the input shaft.

26. Remove the rubber ring from the gearshift rod joint.

27. Remove the gearshift rod bushings and the bell housing seal.

28. Disconnect the synchronizer hubs by pushing the hubs out of the sleeves. Clean all parts in solvent and examine the gears carefully for any signs of cracks or scoring, particularly in the tooth areas. Check the synchronizers for excessive wear, and examine the bearings closely for any sign of scoring or cracks.

29. Begin reassembly by building up the synchronizer hubs. Position the hub in the sleeve so that slots align with the chamfered teeth within the sleeve. Insert the dogs (three in each synchro) and lock them in place with the springs.

30. Using the proper drivers, install the bell housing seal, position a new rubber ring in the shifter joint and install new bushings on the gearshift rod. Use grease to retain the rubber ring on the right side of the shifter rod.

31. Install a new seal for the selector rail in the case.

32. Using the press, assemble the 3rd gear and its synchronizer ring and install the assembly with the 3rd-4th synchronizer hub onto the main shaft. Repeat the procedure for the 2nd gear and synchronizer hub and install it with the 1st-2nd synchronizer onto the mainshaft. On M47 units, assemble 5th

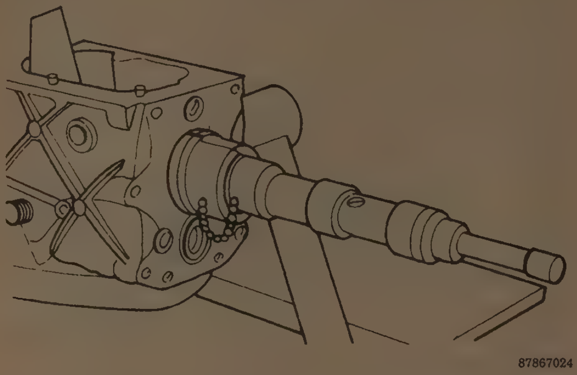


Fig. 30 Special Volvo tools are shown in place to facilitate the mainshaft bearing removal — note counterholding tool No. 2985 in the case

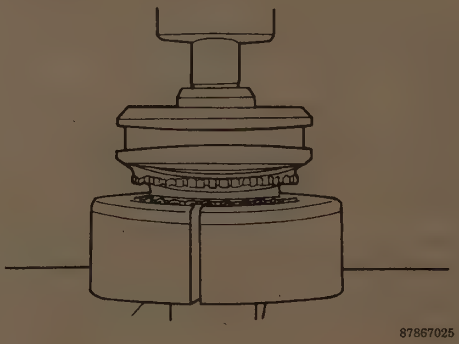


Fig. 31 Press out the synchronizer hub and gear — note the special tool properly supporting the assembly

gear and its attendant synchronizer parts onto the intermediate shaft. Don't forget the locking rings (circlips) for each assembly.

33. Install the 1st gear and synchronizer ring onto the mainshaft.

34. Using a drift of the correct size, install the two intermediate shaft bearings onto the shaft.

➡The bearings for the small end of the intermediate shaft are different for diesel applications. Make sure you use the correct bearing for your application.

35. Install the bearing on the input shaft. Install the lock ring on the input shaft but DO NOT install the spacer ring at this time. It will be installed later in the procedure.

36. Follow this sub-procedure only if transmission case is aluminum:

a. Position the intermediate shaft in its housing. Position the outer races for the intermediate shaft bearings in the case.

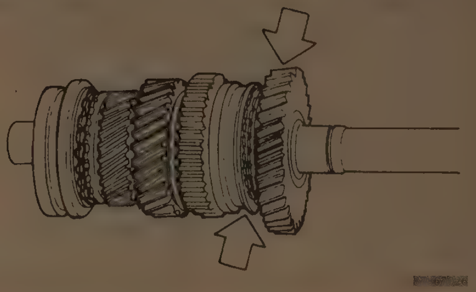


Fig. 32 When installed correctly on the mainshaft, the first gear/synchronizer should look like this

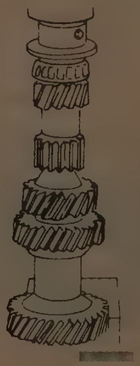


Fig. 33 Install the bearing on the intermediate shaft — Volvo special tool shown

b. Install the bell housing with its gasket and torque its bolts to 30 ft. lbs. (41 Nm).

c. Turn the transmission to a vertical position. Eliminate any play in the intermediate shaft bearings by tapping the bearing race until the clearance is gone and the shaft does not rotate easily.

d. Using an accurate metric depth gauge, measure the distance between the (intermediate shaft bearing) outer race and the rear surface of the case.

e. Calculate the thickness of shims for the intermediate shaft. Keep all your measurements and calculations in millimeters; replacement shims are not referenced in inch units. Start with the depth just measured--let's say 1.50mm--and add 0.25mm for the gasket thickness. (1.50 + 0.25 = 1.75mm) The shaft free-play spec is 0.03-0.08mm, so add that to your total. (1.75 + 0.03 to 0.08 = 1.78 to 1.83mm). Since shims are available only in multiples of 5, we choose in our example shims totalling 1.80mm. Select the shims and set them aside; don't install them yet.

f. Since this was only for the purposes of preliminary measurement, remove the bellhousing and its gasket, remove the outer races for the intermediate shaft bearings and lift out the intermediate shaft.

37. Install the reverse gear shifter and lock ring. Install reverse gear and its shaft.

38. Check and adjust the position of the reverse gear shaft in the case. It should be 0.002 in. (0.05mm) below the housing face.

39. Adjust the clearance between reverse gear and the shift fork. Correct clearance is 0.004-0.04 in. (0.1-1.0mm). Perform adjustments by tapping the shift fork pivot pin with a punch to move it.

40. Position the intermediate shaft (and its extension for M47) in the bottom of the transmission case.

41. Position the main shaft in its housing.

42. Put the thrust washer and bearing on the mainshaft. The bearing should have its positioning ring in place.

43. Using Volvo tool No. 2831 or similar, press the mainshaft bearing into position. Press so that reverse gear is loaded towards the center of the transmission. Make sure that gears do not contact each other and cause damage.

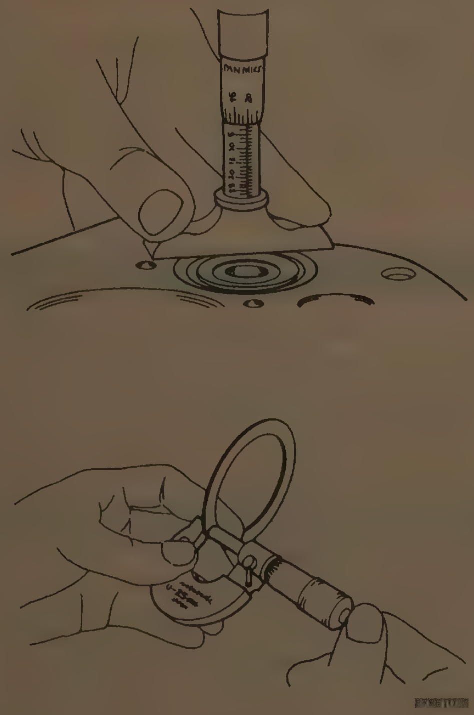


Fig. 34 Use a metric depth gauge to take necessary measurements, then select the correct shim(s) based on your calculations

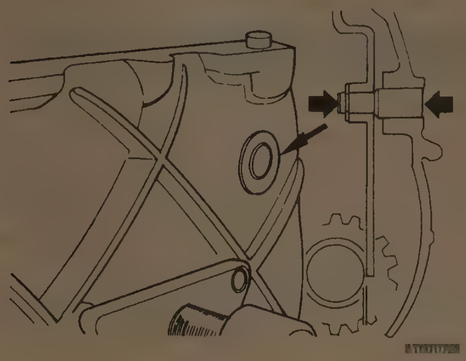


Fig. 35 Move the mounting pin as necessary to adjust the clearance between reverse gear and its shift fork to 0.004-0.040 in. (0.10-1.00mm)

44. Install the lock ring for the mainshaft bearing.

45. For M46 units, place the locking key in the mainshaft keyway and install the overdrive oil pump eccentric and its locking ring.

46. Coat the bearing with grease and install the roller bearing into the input shaft.

47. Place the 4th gear synchronizer ring in the hub.

48. Attach the input shaft to the mainshaft and push it in all the way. Lift up the intermediate shaft so that the bearings are correctly positioned in the housing.

49. Pull out the input shaft so that the spacer ring can be positioned on the bearing. Push the shaft back in; the spacer should lie against the housing.

50. Install the outer races for the intermediate shaft bearings. On units in aluminum cases, use a drift of the correct diameter.

51. Using a metric depth gauge, measure the distance between the front end of the input shaft bearing and the front surface of the case. Record this number. Now measure the

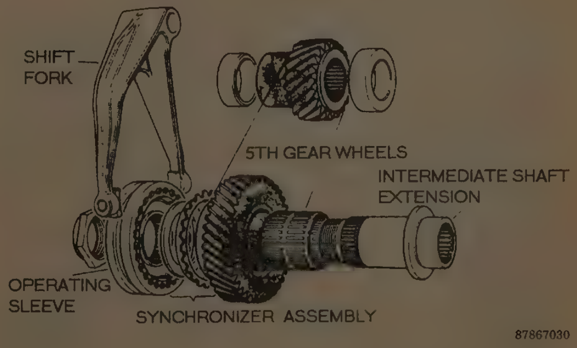


Fig. 36 Exploded view of the 5th gear components — M47 transmission

distance between the surface of the bell housing and the bottom of the bearing case. The following calculation will compute the necessary thickness of the shims for the input shaft. Start with the distance from the bell housing surface to the bottom of the bearing seat--for example, let's say 5.60mm — and add to it the known thickness of the gasket, 0.25mm. (5.60 + 0.25 = 5.85). From the result, subtract the distance between the front of the input shaft bearing and the front of the case — for our example, 4.71mm. (5.85 - 4.71 = 1.04). Now subtract the allowable free-play in the shaft--0.01 to 0.15mm--to get the final shim thickness. (1.04 - 0.01 to 0.15 = 1.03 to 0.89). The nearest shim thickness to our need is 0.90mm.

52. Install the bell housing with its gasket; for aluminum cases, install the clutch fork and spacer. Tighten the bolts to 30 ft. lbs. (41 Nm).
53. Install the clutch release (throwout) bearing.
54. Turn the transmission to a vertical position. For aluminum cased units, remove any free-play in the intermediate shaft by using a drift to tap the bearing race until the shaft has noticeable drag when turning. For units with iron cases, measure the distance between the outer race of the intermediate shaft bearing and the surface of the housing. To this measurement, add the known thickness of the gasket, 0.25mm. Subtract the allowable clearance, 0.025 to 0.10mm, and choose the shim or combination of shims closest to the total.
55. For both iron and aluminum cases, determine and select shims for the mainshaft in the following manner:
    a. Measure the distance between the front of the mainshaft bearing and the surface of the transmission case. Also measure the distance between the rear cover surface and the bottom of the bearing seat.
    b. Beginning with the rear measurement (cover-to-bearing seat), add the known thickness of the gasket, 0.25mm.
    c. From that total, subtract the front bearing-to-case surface measurement.
    d. From that result, subtract the allowable clearance (free-play), 0.01 to 0.20mm. Select the shim closest to the total.
56. Install the shift forks; make sure the lugs are in their correct position. Install the shifter and the gear selection rails.
57. Position the gasket and shim pack for the intermediate shaft. (For aluminum cases, this shim thickness was computed in step 35. For iron units, it was computed in step 53).
58. Position the mainshaft shim pack in the intermediate housing or, on M45, the rear cover.
59. Install the cover (M45) or the housing (M46), and secure with the two lower bolts finger tight. On M45 units, install the drive flange and tighten the bolts to 65-75 ft. lbs. (88-102 Nm)On M45, install the speedometer gear and O-ring at this time.
60. Install the gearshift rod and carrier. Tighten the bolts to 30 ft. lbs. (41 Nm).
61. Install and tighten remaining bolts for rear cover or intermediate housing. Correct torque is 30 ft. lbs. (41 Nm).
62. Install the lock pin for the shifter, install the selector plate assembly and the return spring.
63. Install the gearshift lever (without its lockscrew and lockring) on the transmission. Hold the selector plate assembly with the palm of your hand and move the shifter through all the gears. Check for proper engagement and release of each gear. Make necessary corrections before proceeding. Remove the shifter.
64. Install the detent ball and spring; install a new gasket for the top cover.
65. Install the top cover and tighten the bolts to 15 ft. lbs. (20 Nm).
66. Reinstall the overdrive switch, the reverse light switch and the wiring at the solenoid. The unit may be refilled with oil now or after installation in the car.

Clutch

The purpose of the clutch is to disconnect and connect engine power at the transmission. A car at rest requires a lot of engine torque to get all that weight moving. An internal combustion engine does not develop a high starting torque (unlike steam engines), so it must be allowed to operate without any load until it builds up enough torque to move the car. Torque increases with engine rpm. The clutch allows the engine to build up torque by physically disconnecting the engine from the transmission, relieving the engine of any load or resistance. The transfer of engine power to the transmission (the load) must be smooth and gradual; if it weren't, drive line components would wear out or break quickly. This gradual power transfer is made possible by gradually releasing the clutch pedal. The clutch disc and pressure plate are the connecting link between the engine and transmission. When the clutch pedal is released, the disc and plate contact each other (clutch engagement), physically joining the engine and transmission. When the pedal is pushed in, the disc and plate separate (the clutch is disengaged), disconnecting the engine from the transmission.

The clutch assembly consists of the flywheel, the clutch disc, the clutch pressure plate, the throwout bearing and fork, the actuating linkage and the pedal. The flywheel and clutch pressure plate (driving members) are connected to the engine crankshaft and rotate with it. The clutch disc is located between the flywheel and pressure plate, and splined to the transmission shaft. A driving member is one that is attached to the engine and transfers engine power to a driven member (clutch disc) on the transmission shaft. A driving member (pressure plate) rotates (drives) a driven member (clutch disc) on contact and, in so doing, turns the transmission shaft. There is a circular diaphragm spring within the pressure plate cover (transmission side). In a relaxed state (when the clutch pedal is fully released), this spring is convex; that is, it is dished outward toward the transmission. Pushing in the clutch pedal actuates an attached linkage rod. Connected to the other end of this rod is the throwout bearing fork. The throwout bearing is attached to the fork. When the clutch pedal is depressed, the clutch linkage pushes the fork and bearing forward to contact the diaphragm spring of the pressure plate. The outer edges of the spring are secured to the pressure plate and are pivoted on rings so that when the center of the spring is compressed by the throwout bearing, the outer edges bow outward and, by so doing, pull the pressure plate in the same direction away from the clutch disc. This action separates the disc from the plate, disengaging the clutch and allowing the transmission to be shifted into another gear. A coil type clutch return spring attached to the clutch pedal arm permits full release of the pedal. Releasing the pedal pulls the throwout bearing away from the diaphragm spring resulting in a reversal of spring position. As bearing pressure is gradually released from the spring center, the outer edges of the spring bow outward, pushing the pressure plate into closer contact with the clutch disc. As the disc and plate move closer together, friction between the two increases and slippage is reduced until, when full spring pressure is applied (by fully releasing the pedal), The speed of the disc and plate are the same. This stops all slipping, creating a direct connection between the plate and disc which results in the transfer of power from the engine to the transmission. The clutch disc is now rotating with the pressure plate at engine speed and, because it is splined to the transmission shaft, the shaft now turns at the same engine speed. Understanding clutch operation can be rather difficult at first; if you're still confused after reading this, consider the following analogy. The action of the diaphragm spring can be compared to that of an oil can bottom. The bottom of an oil can is shaped very much like the clutch diaphragm spring and pushing in on the can bottom and then releasing it produces a similar effect. As mentioned earlier, the clutch pedal return spring permits full release of the pedal and reduces linkage slack due to wear. As the linkage wears, clutch free-pedal travel will increase and free-travel will decrease as the clutch wears. Free-travel is actually throwout bearing lash.

The diaphragm spring type clutches used are available in two different designs: flat diaphragm springs or bent spring. The bent fingers are bent back to create a centrifugal boost ensuring quick re-engagement at higher engine speeds. This design enables pressure plate load to increase as the clutch disc wears and makes low pedal effort possible even with a heavy-duty clutch. The throwout bearing used with the bent finger design is 1¼ in. (31.75mm) long and is shorter than the bearing used with the flat finger design. These bearings are not interchangeable. If the longer bearing is used with the bent finger clutch, free-pedal travel will not exist. This results in clutch slippage and rapid wear.

The transmission varies the gear ratio between the engine and rear wheels. It can be shifted to change engine speed as driving conditions and loads change. The transmission allows disengaging and reversing power from the engine to the wheels.

✲✲CAUTION

The clutch driven disc may contain asbestos, which has been determined to be a cancer causing agent. Never clean clutch surfaces with compressed air! Avoid inhaling dust from any clutch surface! When cleaning clutch surfaces, use a commercially available brake cleaning fluid.

All 1970 and later model Volvos are equipped with either Borg and Beck, or else Fichtel and Sachs diaphragm spring clutches. The 140, 240, 1800 series, DL, GL, GT, and Diesel models use an 8½ in. (216mm) clutch disc. The carburetor equipped 164, 260, GLE, Coupe, and the 760 GLE uses a 9 in. (229mm) clutch disc. The 260, GLE, Coupe, and the 760 GLE with the B28F V6 and later 700 series use a hydraulically operated clutch, incorporating a clutch master cylinder and slave cylinder. There is no effective adjustment in this type of system. All other models use a cable operated clutch.

Adjustment

CABLE ACTUATED CLUTCHES

➧ See Figures 37, 38, 39, 40 and 41

➡No adjustment is possible on the hydraulic clutch.

1. Loosen the locknut for the fork on the clutch cable.
2. Make the necessary adjustment and tighten the locknut. The free-play (A) at the fork should be 3-5mm for all 4-cylinder engines except the Turbo, 1-3mm for the Gas and Diesel Turbo engines, and 4-5mm for the 164.
3. If this adjustment is insufficient, or if a new cable is installed, the sleeve attachment to the flywheel housing should be adjusted with the adjusting nuts. The free-play adjusted at the fork will be noticeable as free-play in the pedal.

Fig. 37 Spray on a penetrating lubricant and allow it to soak a few minutes before loosening the locknut

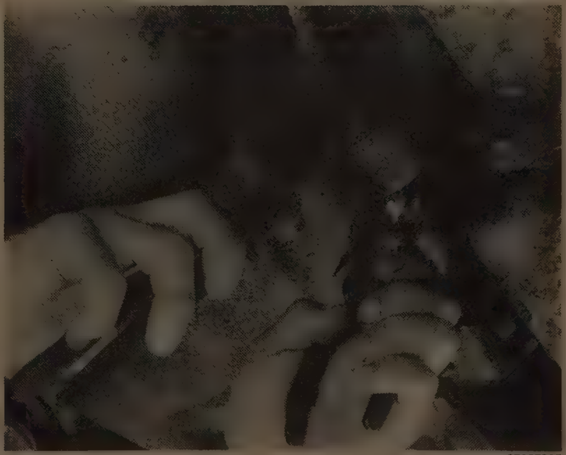


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Fig. 38 Use pliers to perform the adjustment

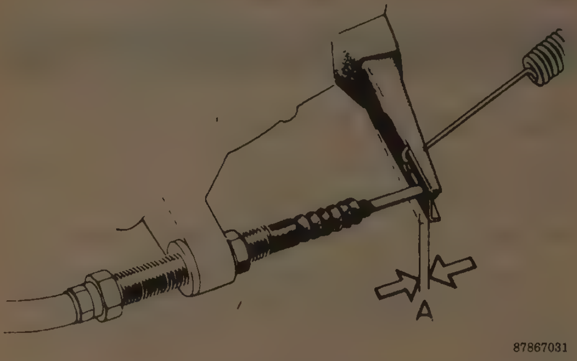


Fig. 39 To adjust the clutch cable, turn the adjuster, then tighten the locknut — manual (non-hydraulic) clutches

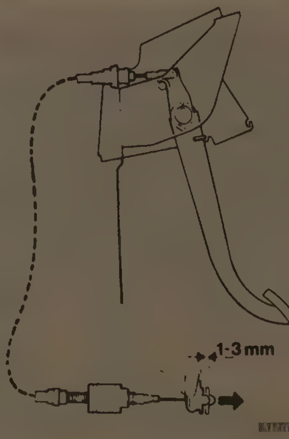


Fig. 40 Adjust the — Turbo engines clutch cable free-play clearance to the specification shown

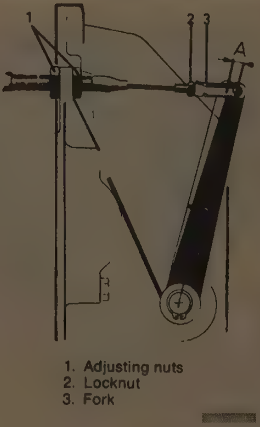


Fig. 41 Adjust the clutch free-play at the points indicated — 164 models

Clutch Assembly

REMOVAL & INSTALLATION

Sections are identified by transmission model. See manual transmission identification paragraph at the beginning of this chapter to identify the transmission in your vehicle.

M40, M41 Transmissions

➧ See Figure 42

1. Remove the transmission as outlined in the applicable Transmission Removal and Installation procedure.
2. Remove the upper bolt for the starter motor.
3. Remove the throwout bearing. Disconnect the cable at the release lever (fork) and loosen the sleeve at its bracket.
4. Remove the bolts which retain the flywheel (clutch) housing to the engine, and lift off the housing.
5. Remove the bolt for the release fork ball joint, remove the ball and the release fork.
6. Scribe alignment marks on the clutch and flywheel. In order to prevent warpage, slowly loosen the bolts holding the clutch to the flywheel in a diagonal pattern. Remove the bolts and lift off the clutch and pressure plate.
7. Inspect the clutch assembly.
8. When ready to install, wash the pressure plate and flywheel with solvent to remove any traces of oil, and wipe them clean with a cloth.

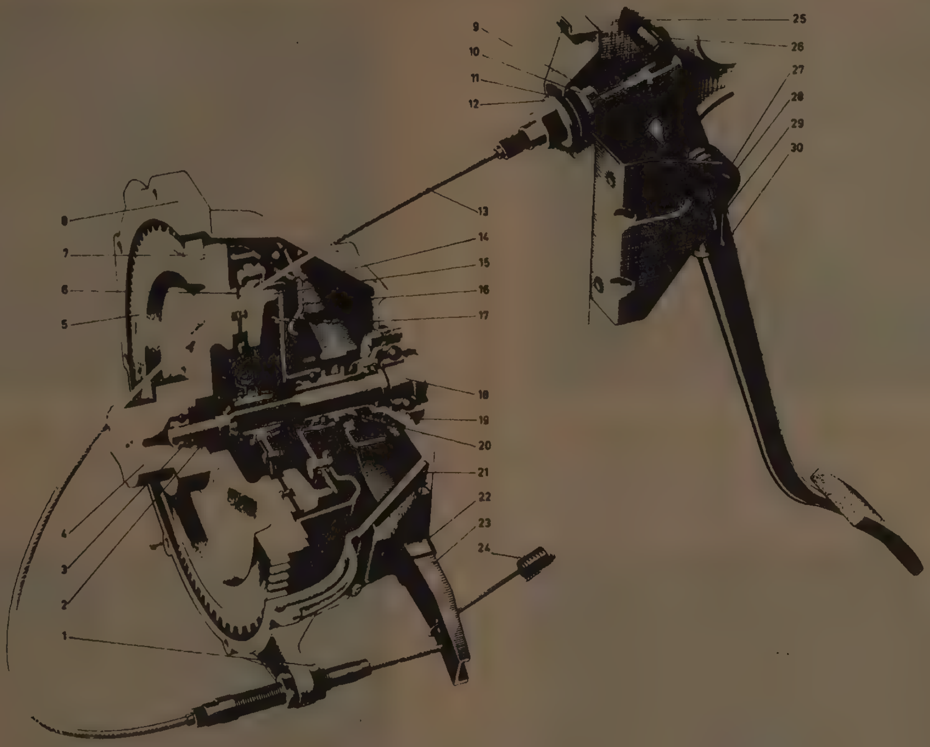
To install:

9. Position the clutch assembly (the longest side of the hub facing backward) to the flywheel and align the bolt holes. Insert a pilot shaft (centering mandrel), or an input shaft from an old transmission of the same type, through the clutch assembly and flywheel. This centers the assembly and pilot bearing.
10. Install the six bolts which retain the clutch assembly to the flywheel and tighten them in a diagonal pattern, a few turns at a time. After all the bolt are tightened, remove the pilot shaft (centering mandrel).
11. Install the ball and release fork in the flywheel housing.
12. Place the upper starter bolt in the housing. Position the housing to the engine and first install the four upper bolts (11mm), then the lower bolts (10mm).
13. Insert the cable sleeve in its bracket and install the rear nut. Connect the cable at the release lever (fork), and install the throwout bearing.
14. Install the nut for the upper starter motor bolt.
15. Install the transmission as outlined in the applicable Transmission Removal and Installation section.
16. Adjust the clutch pedal free travel.

M45, M46 and M47 Transmissions

➧ See Figures 43, 44, 45, 46, 47, 48, 49 and 50

1. Remove the transmission.
2. Scribe alignment marks on the clutch and flywheel. In order to prevent warpage, slowly loosen the bolts holding the clutch to the flywheel in a diagonal pattern. Remove the bolts and lift off the clutch and pressure plate.
3. Inspect the clutch assembly.



1. Adjusting nuts
2. Circlip
3. Support bearing in crankshaft
4. Crankshaft
5. Flywheel
6. Clutch plate
7. Clutch cover
8. Flywheel housing
9. Nut
10. Washer
11. Rubber bushing
12. Washer
13. Clutch wire
14. Retainer
15. Pressure plate
16. Thrust spring
17. Support rings
18. Clutch plate shaft (input shaft transmission)
19. Cover, transmission
20. Throw-out bearing
21. Holding plate
22. Dust cover
23. Release fork
24. Return spring
25. Pedal stop
26. Rubber sleeve
27. Bracket
28. Screw for pedal shaft
29. Return spring
30. Clutch pedal

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Fig. 42 Cutaway view of the clutch and control assembly — 140 series and 1800 series

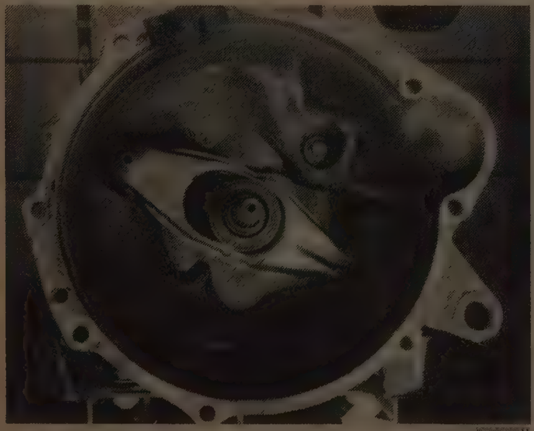


Fig. 43 In the center of this transmission note the pilot shaft mates into the clutch/flywheel assembly

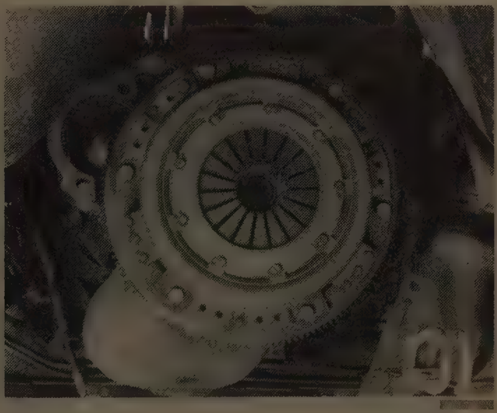


Fig. 44 Before removal, scribe matchmarks on the clutch and flywheel — note the opening to the upper left (this is where the starter engages the ring gear)

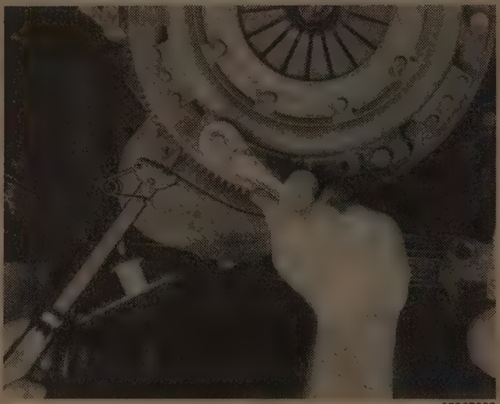


Fig. 45 Slowly loosen the bolts in a crisscross pattern — note the special ring gear tool. Some sort of holding tool is necessary or the assembly will turn

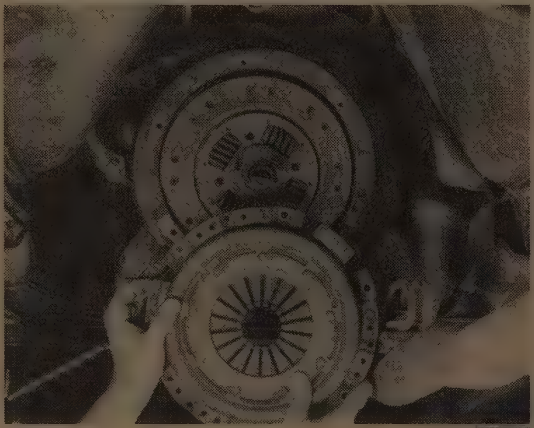


Fig. 46 When unbolted, remove the pressure plate without stirring up any clutch dust

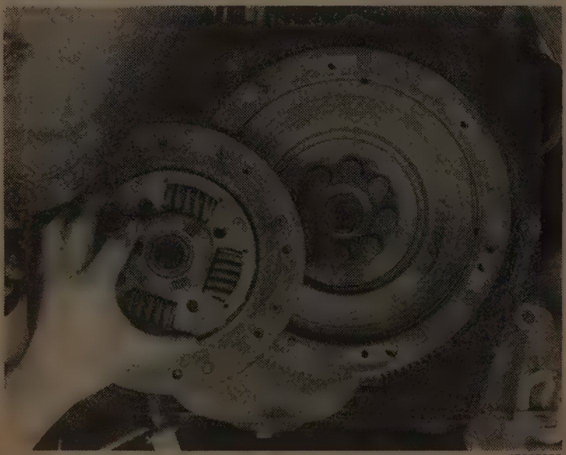


Fig. 47 Remove the clutch fiber plate from the flywheel

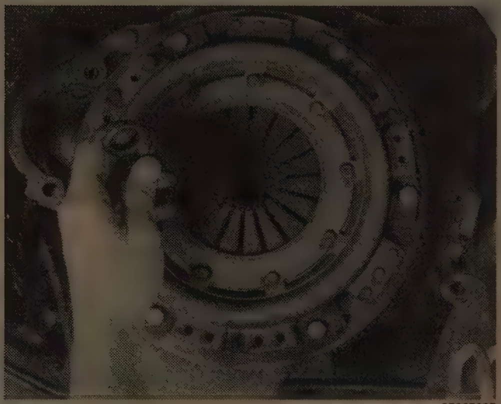


Fig. 48 Insert a centering mandrel through the clutch assembly and flywheel — this step is necessary to install the transmission

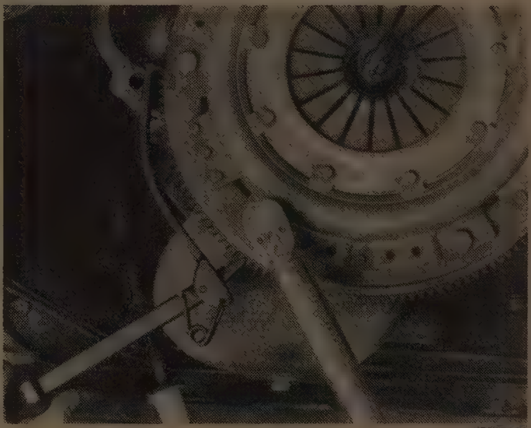


Fig. 49 Tighten the bolts with a torque wrench in a diagonal sequence to the proper tightness

To install:

4. When ready to install, wash the pressure plate and flywheel with solvent to remove any traces of oil, and wipe them clean with a cloth.
5. Position the clutch assembly (the longest side of the hub facing backward or away from the engine) to the flywheel and align the bolt holes. Insert a pilot shaft (centering mandrel), or an input shaft from an old transmission of the same type, through the clutch assembly and flywheel. This centers the assembly and pilot bearing.
6. Install the six bolts which retain the clutch assembly to the flywheel and tighten them in a diagonal pattern, a few turns at a time. After all the bolt are tightened, remove the pilot shaft (centering mandrel).
7. Install the transmission as outlined under "Removal and Installation".
8. On the models so equipped, bleed the clutch hydraulic system, if necessary.

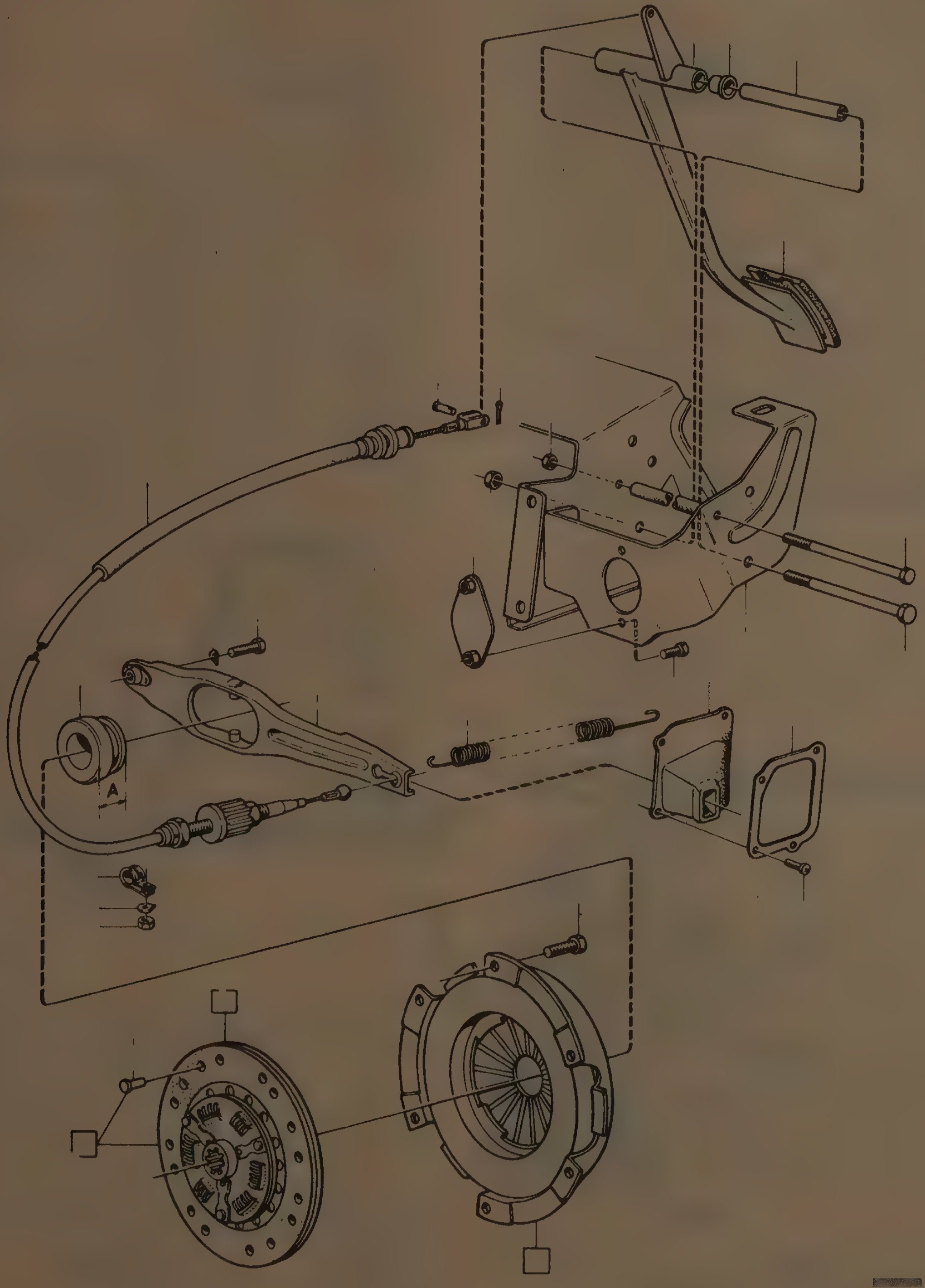


Fig. 50 Exploded view of the clutch and clutch controls — 240 series, 1980 and later DL, GL, GT and Diesel models

M400 and M410 Transmissions

➧ See Figure 51

1. Remove the transmission as outlined in the "Removal and Installation" section.
2. Scribe alignment marks on the clutch and flywheel. In order to prevent warpage, slowly loosen the bolts which retain the clutch assembly to the flywheel diagonally in rotation. Remove the bolts and lift off the clutch and pressure plate.
3. Inspect the clutch assembly.

To install:

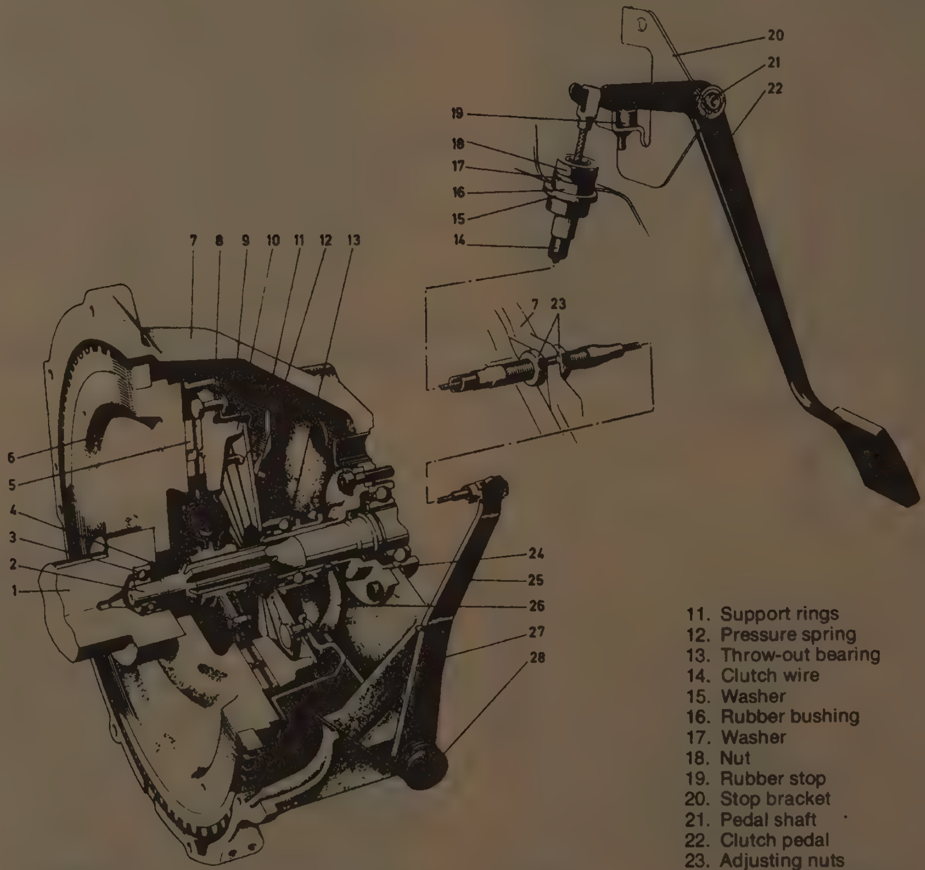
4. When ready to install, wash the pressure plate and flywheel with solvent to remove any traces of oil, and wipe them clean with a cloth.
5. Position the clutch assembly (the longest side of the hub facing backward) to the flywheel and align the bolt holes. Insert a pilot shaft (centering mandrel), or an input shaft from an old transmission of the same type, through the clutch assembly and flywheel so that the flywheel pilot bearing is centered.
6. Install the six bolts which retain the clutch assembly to the flywheel, and tighten them diagonally in rotation, a few turns at a time. After all the bolts are tightened, remove the pilot shaft (centering mandrel).
7. Install the transmission as outlined in the Removal and Installation section.

CLUTCH INSPECTION

➧ See Figures 52 and 53

Check the pressure plate for heat damage, cracks, scoring, or other damage to the friction surface. Check the curvature of the pressure plate with a steel ruler.

Place the ruler diagonally over the pressure plate friction surface and measure the distance between the straight edge of the ruler and the inner diameter of the pressure plate. This measurement must not be greater than 0.008 in. (0.2mm). In addition, there must be no clearance between the straight edge of the ruler and the outer diameter of the pressure plate. This check should be made at several points. Additionally, inspect the tips of the diaphragm springs (fingers) for any sign of wear.



1. Crankshaft
2. Clutch plate shaft (input shaft, transmission)
3. Support bearing in crankshaft
4. Circlip
5. Clutch plate
6. Flywheel
7. Flywheel housing
8. Clutch cover
9. Retainer
10. Thrust plate
11. Support rings
12. Pressure spring
13. Throw-out bearing
14. Clutch wire
15. Washer
16. Rubber bushing
17. Washer
18. Nut
19. Rubber stop
20. Stop bracket
21. Pedal shaft
22. Clutch pedal
23. Adjusting nuts
24. Cover, transmission
25. Lever and release shaft
26. Release fork
27. Return spring
28. Washer

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Fig. 51 Cutaway view of the clutch and control assembly — 164 models

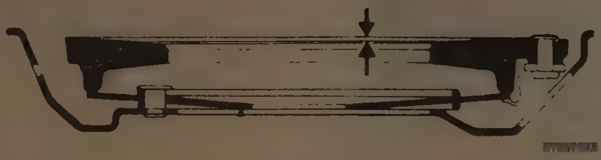


Fig. 52 Always check the pressure plate for warpage — the distance between the arrows must not exceed 0.008 in. (0.20mm)

Replace the clutch as a unit (disc, pressure plate and throwout bearing) if any fault is found.

Check the throwout bearing by rotating it several times while applying finger pressure, so that the ball bearings roll against the inside of the races. If the bearing does not turn easily or if it binds at any point, replace it as a unit. Also make sure that the bearing slides easily on the guide sleeve from the transmission.

Inspect the clutch disc for signs of slippage (burns) or oil contamination. Make sure the rivets are not loose and that the clutch contact surfaces are well above the rivet heads. The thickness of the disc above the rivet heads is the "remaining life" of the disc; always replace the disc if in doubt.

When reassembling, apply grease to the splines and end shaft, the throwout bearing and the pivot ball and seat of the clutch fork.

Clutch Master Cylinder

REMOVAL & INSTALLATION

➧ See Figure 54

1. Drain the clutch reservoir with a bulb syringe. Be careful not to drip brake fluid on any painted surfaces.
2. Remove the underdash panel and remove the lockring and pin from the clutch pedal.
3. Remove the hose from the master cylinder. Use a clean jar to collect spillage.
4. Remove the two retaining bolts and remove the master cylinder.
5. When reinstalling, make sure that the clearance (free-play) between the pushrod and piston is 0.04 in. (1mm). Make certain the hose is correctly threaded and secure. Top up the fluid and bleed the system as explained below.

Clutch Slave Cylinder

REMOVAL & INSTALLATION

1. Raise and support the front end on jackstands.
2. Disconnect the fluid line at the cylinder.
3. Unbolt the cylinder from the flywheel housing.
4. Installation is the reverse of removal. Be sure to bleed the system after installation.

Hydraulic Clutch Bleeding

The hydraulic clutch system should be bled any time the hoses have been loosened or any component replaced. The bleeding process is quite simple and eliminates any air which has become trapped within the lines.

Add brake fluid to the reservoir. Attach a length of hose to the bleeder nipple on the slave cylinder (at the transmission) and put the other end in a clear glass jar. Put enough brake fluid in the jar to cover the end of the hose.

Have an assistant press the clutch pedal to the floor and open the bleed screw on the slave cylinder. Close off the bleeder while the pedal is still depressed and repeat the process with another application of the clutch pedal. As the bleeder is released each time, observe the fluid in the jar. When no bubbles are coming out of the hose, the system is bled. Secure the fitting, remove the hose and jar, and top up the brake fluid to its proper level.

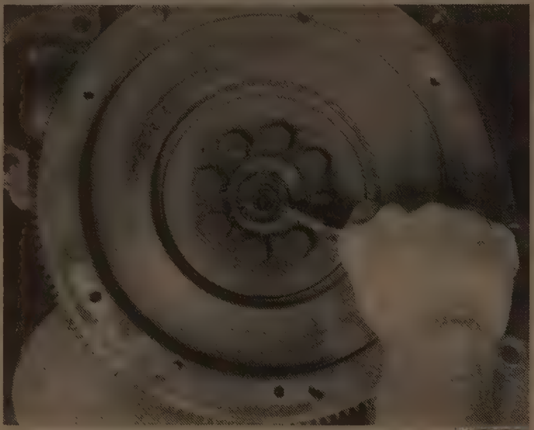


Fig. 53 Note the score marks on this flywheel, it should be removed and inspected for damage or uneven wear

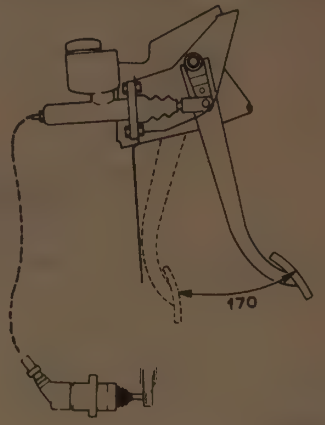


Fig. 54 clutch master cylinder and slave cylinder design — pedal travel is 6.7 in. (170mm)

AUTOMATIC TRANSMISSION

Understanding Automatic Transmissions

The automatic transmission allows engine torque and power to be transmitted to the rear wheels within a narrow range of engine operating speeds. The transmission will allow the engine to turn fast enough to produce plenty of power and torque at very low speeds, while keeping it at a sensible rpm at high vehicle speeds. The transmission performs this job entirely without driver assistance. The transmission uses a light fluid as the medium for the transmission of power. This fluid also works in the operation of various hydraulic control circuits and as a lubricant. Because the transmission fluid performs all three of these functions, trouble within the unit can easily travel from one part to another. For this reason, and because of the complexity and unusual operating principles of the transmission, a very sound understanding of the basic principles of operation will simplify troubleshooting.

THE TORQUE CONVERTER

The torque converter replaces the conventional clutch. It has three functions:

1. It allows the engine to idle with the vehicle at a standstill, even with the transmission in gear.
2. It allows the transmission to shift from range-to-range smoothly, without requiring that the driver close the throttle during the shift.
3. It multiplies engine torque to an increasing extent as vehicle speed drops and throttle opening is increased. This has the effect of making the transmission more responsive and reduces the amount of shifting required.

The torque converter is a metal case which is shaped like a sphere that has been flattened on opposite sides. It is bolted to the rear end of the engine's crankshaft. Generally, the entire metal case rotates at engine speed and serves as the engine's flywheel.

The case contains three sets of blades. One set is attached directly to the case. This set forms the torus or pump. Another set is directly connected to the output shaft, and forms the turbine. The third set is mounted on a hub which, in turn, is mounted on a stationary shaft through a one-way clutch. This third set is known as the stator.

A pump, which is driven by the converter hub at engine speed, keeps the torque converter full of transmission fluid at all times. Fluid flows continuously through the unit to provide cooling.

Under low-speed acceleration, the torque converter functions as follows:

The torus is turning faster than the turbine. It picks up fluid at the center of the converter and, through centrifugal force, slings it outward. Since the outer edge of the converter moves faster than the portions at the center, the fluid picks up speed.

The fluid then enters the outer edge of the turbine blades. It then travels back toward the center of the converter case along the turbine blades. In impinging upon the turbine blades, the fluid loses the energy picked up in the torus.

If the fluid were now to immediately be returned directly into the torus, both halves of the converter would have to turn at approximately the same speed at all times, and torque input and output would both be the same.

In flowing through the torus and turbine, the fluid picks up two types of flow, or flow in two separate directions. It flows through the turbine blades, and it spins with the engine. The stator, whose blades are stationary when the vehicle is being accelerated at low speeds, converts one type of flow into another. Instead of allowing the fluid to flow straight back into the torus, the stator's curved blades turn the fluid almost 90° toward the direction of rotation of the engine. Thus the fluid does not flow as fast toward the torus, but is already spinning when the torus picks it up. This has the effect of allowing the torus to turn much faster than the turbine. This difference in speed may be compared to the difference in speed between the smaller and larger gears in any gear train. The result is that engine power output is higher, and engine torque is multiplied.

As the speed of the turbine increases, the fluid spins faster and faster in the direction of engine rotation. As a result, the ability of the stator to redirect the fluid flow is reduced. Under cruising conditions, the stator is eventually forced to rotate on its one-way clutch in the direction of engine rotation. Under these conditions, the torque converter begins to behave almost like a solid shaft, with the torus and turbine speeds being almost equal.

THE PLANETARY GEARBOX

The ability of the torque converter to multiply engine torque is limited. Also, the unit tends to be more efficient when the turbine is rotating at relatively high speeds. Therefore, a planetary gearbox is used to carry the power output of the turbine to the driveshaft.

Planetary gears function very similarly to conventional transmission gears. However, their construction is different in that three elements make up one gear system, and, in that all three elements are different from one another. The three elements are: an outer gear that is shaped like a hoop, with teeth cut into the inner surface; a sun gear, mounted on a shaft and located at the very center of the outer gear; and a set of three planet gears, held by pins in a ring-like planet carrier, meshing with both the sun gear and the outer gear. Either the outer gear or the sun gear may be held stationary, providing more than one possible torque multiplication factor for each set of gears. Also, if all three gears are forced to rotate at the same speed, the gearset forms, in effect, a solid shaft.

Most modern automatics use the planetary gears to provide either a single reduction ratio of about 1.8:1, or two reduction gears: a low of about 2.5:1, and an intermediate of about 1.5:1. Bands and clutches are used to hold various portions of the gearsets to the transmission case or to the shaft on which they are mounted. Shifting is accomplished, then, by changing the portion of each planetary gearset which is held to the transmission case or to the shaft.

THE SERVOS & ACCUMULATORS

The servos are hydraulic pistons and cylinders. They resemble the hydraulic actuators used on many familiar machines, such as bulldozers. Hydraulic fluid enters the cylinder, under pressure, and forces the piston to move to engage the band or clutches.

The accumulators are used to cushion the engagement of the servos. The transmission fluid must pass through the accumulator on the way to the servo. The accumulator housing contains a thin piston which is sprung away from the discharge passage of the accumulator. When fluid passes through the accumulator on the way to the servo, it must move the piston against spring pressure, and this action smooths out the action of the servo.

THE HYDRAULIC CONTROL SYSTEM

The hydraulic pressure used to operate the servos comes from the main transmission oil pump. This fluid is channeled to the various servos through the shift valves. There is generally a manual shift valve which is operated by the transmission selector lever and an automatic shift valve for each automatic upshift the transmission provides: i.e., 2-speed automatics have a low-high shift valve, while 3-speeds have a 1-2 valve, and a 2-3 valve.

There are two pressures which effect the operation of these valves. One is the governor pressure which is affected by vehicle speed. The other is the modulator pressure which is affected by intake manifold vacuum or throttle position. Governor pressure rises with an increase in vehicle speed, and modulator pressure rises as the throttle is opened wider. By responding to these two pressures, the shift valves cause the upshift points to be delayed with increased throttle opening to make the best use of the engine's power output.

Most transmissions also make use of an auxiliary circuit for downshifting. This circuit may be actuated by the throttle linkage or the vacuum line which actuates the modulator, or by a cable or solenoid. It applies pressure to a special downshift surface on the shift valve or valves.

The transmission modulator also governs the line pressure, used to actuate the servos. In this way, the clutches and bands will be actuated with a force matching the torque output of the engine.

The transmission used on 1975 and earlier models is a 3-speed, dual-range, Borg-Warner model 35. The BW 35 consists of a three element torque converter coupling, planetary gear set, and a valve control system. A similar Borg-Warner (BW) 55 or Aisin-Warner (AW) 55 (made in Japan under license) is used beginning in the 1976 and later models. The AW70 and the heavy duty AW71 are 4-speed automatic transmissions available since 1982. The AW71 is used with the higher torque B23F/B230F Turbo and the B28/B280 V6 engines.

The ZF (Zahnrad Fabrik) 4HP22 was introduced in 1985. It is a four speed automatic gearbox with a lock-up clutch. This clutch locks in place when the transmission is in fourth gear, effectively making fourth an overdrive. While the ZF22 was introduced on the D24 engine, it is also found coupled to some late model B230F engines.

The transmission type designation, serial number and part number are stamped on a metal plate which is riveted to the left side of the case on automatic transmissions.

Fluid Pan

REMOVAL & INSTALLATION

****CAUTION**

If the vehicle has been driven within the last 3-5 hours the fluid may be scalding hot. Use extreme caution when draining fluid or handling components.

1970-75 BW 35

1. Place the transmission selector in PARK.
2. Raise the vehicle and place jackstands underneath.
3. The drain plug is located on the pan. Place a container underneath to catch the fluid.
4. After the fluid has stopped draining, remove the 15 pan retaining bolts and remove the pan and gasket.
5. Inspect the magnetic element in the pan for metal shavings or chips. Also remove any sludge or gum from the bottom of the pan. Clean the mating surfaces of the transmission case and pan.
6. Position the pan (with a new gasket) to the case and install the 15 retaining bolts. Tighten all the bolts only finger tight first, then tighten them to 8-13 ft. lbs. in an alternating pattern across the pan. Coat the threads of the drain plug with sealing or locking compound such as Loctite®. Install the plug and a new plug gasket and torque to 8-10 ft. lbs..
7. Remove the jackstands and lower the vehicle. Refer to the capacities chart and fill the transmission to the proper level (between the MAX and MIN marks for a cold transmission) with type F automatic transmission fluid.

1976 and Later BW55, AW55, AW70, AW71 and ZF22 Transmissions

1. Raise the car and place jackstands underneath.
2. On older models, the dipstick tube doubles as the filler tube, and when removed, the drain plug. If no drain plug is evident in the pan, disconnect the tube from the side of the pan, and drain the transmission. The ZF22 has a drain plug in the bottom of the pan as do the later BW and AW units.
3. Remove the 14 pan bolts and lower the pan and gasket. Some fluid will remain in the pan. On the ZF22, note the two different types of retaining clips; the ones with the rounded edges mount at the corners of the pan.
4. Inspect the magnet (located adjacent to the filter screen) for metal particles. Check the filter screen for the pump. Remove any gum or sludge from the bottom of the pan. Clean and dry the pan and install a new gasket.
5. Position the pan and install the bolts finger tight. Then tighten them to 4-7 ft. lbs. in an alternating pattern across the pan.
6. Connect the dipstick tube if removed and tighten to 59-74 ft. lbs. (80-100 Nm).
7. Remove the jackstands and lower the car. Refer to the capacities chart and fill the transmission to the proper level with ATF Type F.

FILTER (PUMP STRAINER) SERVICE

1. Remove the pan as outlined above.
2. Remove the bolts which retain the front pump wire-mesh strainer to the valve body, and lower the strainer.
3. Clean the strainers in an alcohol-based solvent solution.
4. Position the strainers to the valve body and install the retaining screws and bolts. Torque the bolts to 1.7-2.5 ft. lbs. (BW 35) or 3.7-4.4 ft. lbs. (BW55, AW55, AW70 and AW71).
5. Install the pan with a new gasket as outlined in the "Removal and Installation" section.

Adjustments

FRONT BAND ADJUSTMENT

BW 35 Transmission

1. Remove the pan as outlined in the Pan Removal and Installation section.
2. Insert a 6mm gauge block between the adjusting bolt and the servo cylinder. Tighten the bolt with an inch-pound torque wrench to 10 in. lbs.
3. Adjust the position of the adjusting bolt spring. It should be 1-2 threads from the lever.
4. Remove the gauge block and torque wrench. Make sure that the long end of the adjusting bolt spring is inserted in the cam for the front brake band.
5. Install the pan as outlined in the Pan Removal and Installation section.

REAR BAND ADJUSTMENT

BW 35 Transmission

1. An access hole is provided in the right side of the transmission tunnel. On some 140 series and 164 models, it is necessary to disconnect the right heater duct. Lift up the carpet and position it to one side. Remove the rubber plug from the access hole.
2. Loosen the locknut from the adjusting screw located on the right side of the transmission case.
3. Using a $^5/_{16}$ in. square socket and a foot-pound torque wrench, tighten the adjusting screw to 10 ft. lbs.; then back off the adjusting screw one complete turn.
4. Without disturbing the adjustment, tighten the locknut.
5. Install the rubber plug, fit the carpet, and install the heater duct if removed.

The BW55, AW55, AW70, AW71 and ZF22 transmissions are equipped with a multi-disc (band) system which does not require any adjustment. No provision is made for band adjustment, even at overhaul.

SHIFT LINKAGE ADJUSTMENT

1970-71 140 Series and 164 Model (With BW 35 Transmission)

➧ **See Figure 55**

1. Disconnect the pull rod from the selector shaft lever. Place the selector lever in NEUTRAL.
2. Place the lever on the transmission in the central position. Adjust the length of the pull rod so that, on 140 series models, the ball socket can easily be snapped onto the lever ball, and so that, on 164 models, the pin can easily be pushed through the yoke and lever. When the pull rod is adjusted correctly, the distance to the link in the NEUTRAL position should be equal to the distance to the link in the DRIVE position.

3. Make sure that the gear indicator points correctly on the scale (quadrant). Adjustments are made to the cable sleeve at the indicator.
4. Make sure that the output shaft is locked with the control lever in the PARK position.
5. Connect the pull rod to the selector shaft lever.

1971-73 1800 Series

➧ See Figures 56 and 57

1. Check to make sure that the transmission lever and the lever at the linkage bracket are parallel. If necessary, adjust the length of the lower control rod.
2. Disconnect the upper control rod from the intermediate lever. Place the gear selector in NEUTRAL. Also set the transmission lever to its third (neutral) position. Adjust the length of the upper control rod so that the ball socket aligns with the ball stud. Connect the control rod to the lever.
3. If the upper control rod adjustment is correct, the distances to the inhibitor plate in NEUTRAL and DRIVE (A and B) should be equal.

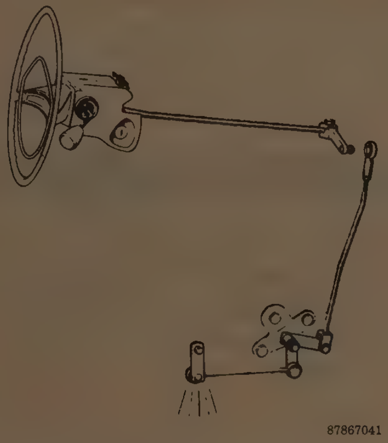


Fig. 55 Adjust the gear selector linkage for proper engagement — 1970 140 series and 164 models

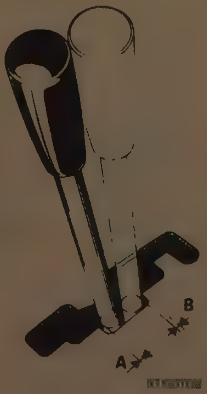


Fig. 56 Adjust the length of the lower control rod to cause the distances to the inhibitor plate in "A" and "B" to be equal

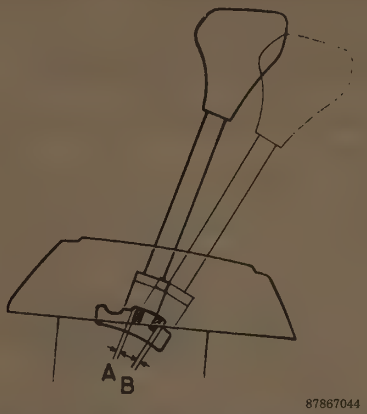


Fig. 57 Adjust the gear selector between the clearances shown according to specification — 1972 and later models except 1800 series

4. Make sure that the output shaft is locked with the selector lever in the PARK position.

1972-73 140 Series and 164 Models

➧ See Figure 58

1. Disconnect the shift rod from the transmission lever. Place both the transmission lever and the gear selector lever in the "2" position.
2. Adjust the length of the shift control rod so that a small clearance (distance B) of 1mm is obtained between the gear selector lever inhibitor and the inhibitor plate when the shift control rod is connected to the transmission lever.
3. Position the gear selector lever in **DRIVE** and make sure that a similar small clearance (distance A) of 1mm exists between the lever inhibitor and the inhibitor plate. Disconnect the shift control rod from the transmission lever and adjust if necessary.
4. Lock the control rod bolt with its safety clasp and tighten the locknut. Make sure that the control rod lug follows with the transmission lever.

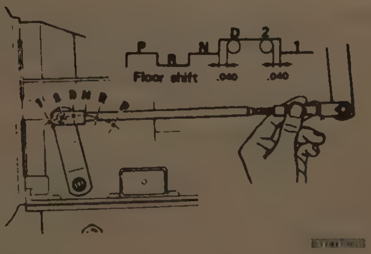


Fig. 58 Adjust the bottom end of the gear selector to set clearance between DRIVE towards NEUTRAL to be the same as "2" towards "1" —

5. After moving the transmission lever to the PARK and "1" positions, make sure that the clearances "A" and "B remain the same. In addition, make sure that the output shaft is locked with the selector lever in the PARK position.

1972-75 140 Series, 164 Models, and 240 Series With BW 35 Transmission

1. Disconnect the shift rod from the transmission lever. Place both the transmission lever and the gear selector lever in the "2" position.
2. Adjust the length of the shift control rod so that a small clearance (distance B) of 1mm is obtained between the gear selector lever inhibitor and the inhibitor plate, when the shift control rod is connected to the transmission lever.
3. Position the gear selector lever in DRIVE and make sure that a similar small clearance (distance A) of 1mm exists between the lever inhibitor and the inhibitor plate. Disconnect the shift control rod from the transmission lever and adjust, if necessary.
4. Lock the control rod bolt with its safety clasp and tighten the locknut. Make sure that the control rod lug follows with the transmission lever.
5. After moving the transmission lever to the PARK and "1" positions, make sure that the clearances "A" and "B" remain the same.

1976 and Later Models Except 700 Series

1. With the engine off, check that the distance between the DRIVE position and its forward stop is equal to the distance between the "2" position and its rearward stop when the gear selector is moved. If you are not sure, remove the gear quadrant cover, and measure.
2. If adjustment is necessary, a rough setting is made by loosening the locknut and rotating the clevis on the control rod to the transmission. A fine adjustment can be made by rotating the knurled sleeve between the control rod locknut and the pivot from the gear selector lever. Increasing the rod length will decrease clearance between the DRIVE position and its forward stop, and vice versa. Maximum permissible length of exposed thread between the locknut and the control rod is 28mm.

700 Series With AW70/71 or ZF22 Transmission

➧ See Figures 59, 60 and 61

➡Before adjusting shift linkage, make sure the starter motor operates only in PARK or NEUTRAL positions; that the back-up light illuminate only in R and that the shift lever is vertical in PARK with the car level.

1. Place the shift lever in PARK.
2. Loosen the locknuts on the adjustment and reaction rods (on the linkage under the car).
3. Make sure the shift lever is in PARK. Turn the driveshaft until it locks in position.
4. Position the gear linkage lever (A) vertically and tighten the locknut. (The gear selector lever may hit the dashboard if the linkage lever is positioned too far backwards.)
5. Press the reaction rod arm backwards until a slight resistance is felt. Tighten the locknut to 3.5 ft. lbs. This is just enough to hold it it in place and still allow adjustment; it will be fully tightened later in the procedure.
6. Move the shift selector to DRIVE and:
    a. For AW70/71 transmissions: Check the free-play in DRIVE when the lever is gently moved towards NEUTRAL. The play should be noticeable and less than or equal to the free-play in **2** when the lever is moved gently towards **1**. If the play is correct, tighten the locknut to 15 ft. lbs. (20 Nm). If the lever is rigid in position **2** (no free-play), move the reaction lever forward about 2.5mm. If the lever is rigid in position DRIVE, move the reaction lever backwards about 2.5mm. Again check free-play and, if correct, tighten the locknut to 15 ft. lbs. (20 Nm).
    b. For ZF22 transmissions: Check the free-play in DRIVE when the lever is gently moved towards NEUTRAL. The play should be noticeable and less than or equal to the free-play in "3" when moved towards "2." If the play is correct, tighten the locknut to 15 ft. lbs. (20 Nm). If the lever is rigid (no free-play) in position "3", move the reaction lever forward about 2.5mm. If the lever is rigid in the DRIVE position, move the lever backwards about 2.5mm. Recheck the

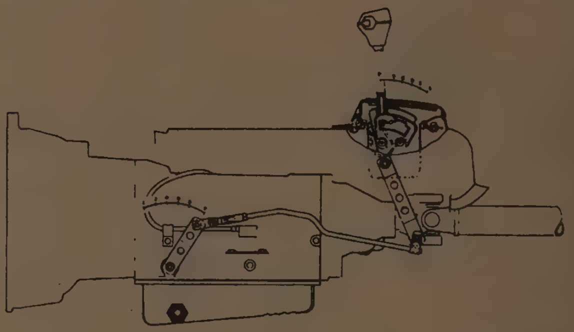


Fig. 59 Loosen the locknuts on the adjustment and reaction rods — AW70/AW71 automatic transmissions

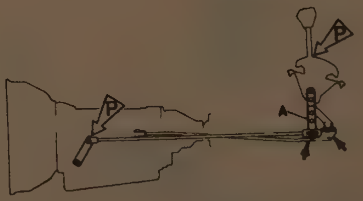


Fig. 60 Adjust rod arm "A" as necessary by turning the locknuts (see arrows) on the adjustment rod (left) or reaction rod (right)

free-play and if correct, tighten the locknut to 15 ft. lbs. (20 Nm).

7. Recheck that the starter engages only in PARK or NEUTRAL and that the reverse lights illuminate only in REVERSE. On certain cars, the reverse lights may not engage after the shift linkage is adjusted; in this case, adjust the reaction lever slightly forward, thereby reducing the play in DRIVE when moved towards NEUTRAL.

THROTTLE AND DOWNSHIFT CABLE ADJUSTMENT

1970-75 Models

Correct adjustment of the throttle cable is imperative for the proper shifting of the transmission. Connect a tachometer to the engine and an oil pressure gauge to the rear of the transmission for this adjustment.

PROCEDURE A

1. Warm up the engine and check the idle speed against specifications in the Tune-Up Chart. Make sure that the throttle cable and cable housing (outer sheath) are attached correctly.
2. On dual carburetor engines, the threaded sleeve should be screwed to within 1/32 in. (0.8mm) of the crimped stop on the cable.

****CAUTION**

Firmly apply the handbrake and block all four wheels. The next test requires momentary acceleration in gear.

3. With one foot firmly on the brake pedal and the accelerator fully depressed, make sure that the carburetor is at the full-open stopped position and that the line pressure reading is 160 psi minimum.

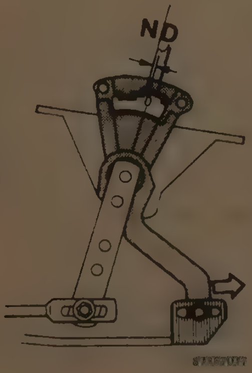


Fig. 61 Check the clearance between "D" and "N" then check between 1st and 2nd

PROCEDURE B

If the cable stop has been damaged, the adjustment disturbed, or if the transmission is not functioning properly, the throttle cable must be adjusted as follows:

1. Firmly apply the parking brake and place blocks in front and in back of the wheels.
2. Place the gear selector in DRIVE. Note the line pressure readings at 700 rpm and 1200 rpm. The line pressure increase between the two readings should be a minimum of 15 psi and a maximum of 20 psi for B20 engines, and 25-30 psi for B30 engines.
3. If the pressure increase is below the standard, the effective length of the outer cable (cable housing) must be increased. If the pressure increase is above specification, shorten the effective length of the cable. The length of the outer cable is determined by the adjuster. Adjust it and retest as necessary.

PROCEDURE C

If the cable itself has been damaged and is in need of replacement, the transmission oil pan must be removed. Refer to "Fluid Pan Removal and Installation". Adjust the new cable as follows:

➡Do not attempt to lubricate the new cable; it is prelubricated.

1. With the pan removed, observe the position of the throttle cable cam (in the transmission) in relation to the accelerator pedal position.
2. With the accelerator fully released and the carburetor lever at the idle stop, the heel of the cam must contact the full diameter of the downshift valve, taking up all of the slack in the inner throttle cable.
3. With the accelerator fully depressed and the carburetor lever at the full-open stop, the constant radius area of the cam must be the point of contact with the downshift valve.
4. Make sure that the outer cable (cable housing) is correctly positioned in its adjuster.

1976 and Later Models (Except Diesel)

➧ See Figure 62

1. The throttle plate angle and throttle cable must be adjusted first. Disconnect the cable at the control pulley and the linkage rod at the throttle shaft.
2. Set the throttle plate angle by loosening the adjusting screw locknut and backing off the screw. Turn in the screw until it just makes contact and then one additional turn. Tighten the locknut.
3. Adjust the linkage rod so that it fits onto the throttle shaft pulley ball without moving the cable pulley. Attach the throttle cable to the pulley and adjust the cable sheath so that the cable is stretched but does not move the cable pulley. Fully depress the gas pedal and check that the pulley contacts the full throttle stop.
4. With the transmission cable hooked up, check that there is 0.010-0.040 in. (0.25-0.60mm) clearance between the cable clip and the adjusting sheath. The cable should be stretched at idle.
5. Pull out the cable about 1/2 in. (13mm) and release. A distinct click should be heard from the transmission as the

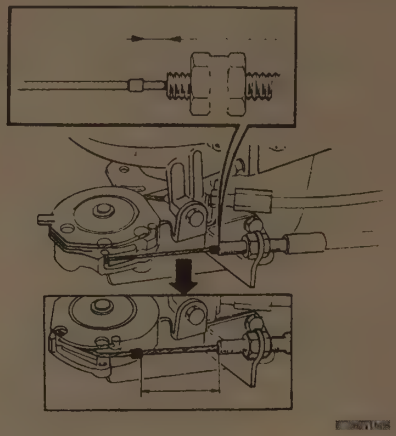


Fig. 62 Adjust the cable in the locations shown — AW70/AW71 and ZF transmissions

throttle cam returns to its initial position. Depress the gas pedal again to wide open throttle. Check that the transmission cable moves about 2 in. (50mm). Adjust as necessary at the adjusting sheath.

Diesel Models

▶ See Figures 63, 64, 65 and 66

If the engine is cold, the cold start device must be disengaged before the linkage can be adjusted. To disengage the cold start device, loosen screw (1) in the illustration, push the lever forward and turn the sleeve 90°

✻✻WARNING

Do not touch screw (2) in the illustration, or the cold start device will have to be reset on the test bench.

To adjust the linkage:

1. Disconnect the link rod lever on the injection pump by unsnapping the plastic clamp on the ball joint of the link rod and pulling the lever off the socket on the accelerator arm.

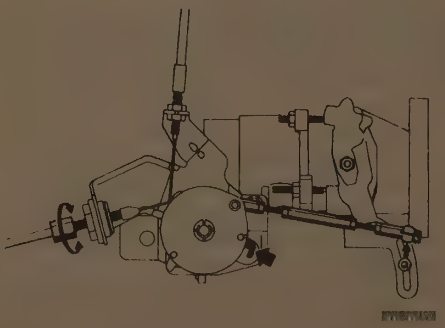


Fig. 63 Disconnect the link rod lever and adjust the cable at its plastic adjuster

2. Turn the plastic cable adjuster until the cable is stretched out but does not cause the pulley to move from its idle stop.
3. Have an assistant press the accelerator pedal to the floor and check to see that the pulley notch touches the maximum speed stop.

➡For manual transmission models, proceed to step 7.

4. To adjust the kickdown cable on models with automatic transmission, have an assistant press the accelerator pedal to the floor and measure how much inner cable is exposed on the kickdown cable. It should be exposed approximately 2.05 in. (52mm) between the end positions.
5. Return the accelerator pedal to idle position. The kickdown cable should be stretched and the distance between the kickdown cable clip and the cable sheath should be 0.01-0.04 in. (0.25-1.00mm).
6. If either of these measurements are not correct, adjust them at the threaded end of the cable sheath.
7. On all models, connect the link rod to the injection pump accelerator arm.
8. Have an assistant floor the accelerator pedal and adjust the link rod length so that the injection pump accelerator arm touches the maximum speed adjusting screw.
9. Return the accelerator pedal to the idle position and check to see that the accelerator arm touches the idle speed adjusting screw. If not, loosen and move the link rod ball joint in its oblong slot on the accelerator arm until the arm touches the idle speed adjusting screw. Tighten the ball joint.
10. Repeat steps 8 and 9 until the linkage is correctly adjusted.

➡A maximum clearance of 0.012 in. (0.3mm) is permitted between the pulley and the maximum speed stop.

11. Reconnect the cold start device, if disconnected.

Neutral Safety (Start Inhibitor) Switch and Reverse Light Switch

ADJUSTMENT AND/OR REPLACEMENT

The neutral safety switch also serves to illuminate the reverse lights. On the earlier models, the switch is found in the transmission case. The system was later simplified and refined; from the mid-1970s onward, the switch is found on the left side of the gearshift selector.

Some switches can be adjusted by moving them on their slotted mounts or threads. Others are fixed in position and can only be removed and replaced.

1970-72 Models

▶ See Figures 67 and 68

1. Check the adjustment of the gear selector as outlined above. Place the gear selector in DRIVE and firmly apply the parking brake.
2. On 1972 140 series and 164 models, remove the shift lever from the transmission.
3. Loosen the locknut for the switch. Label or diagram the position of the wires on the switch and disconnect the electri-

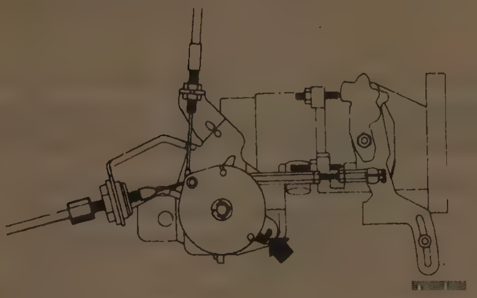


Fig. 64 Depress the accelerator pedal and make sure the pulley notch touches the maximum speed stop

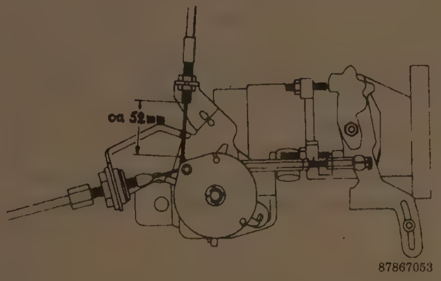


Fig. 65 Adjust the kickdown cable by setting the clearance between the cable clip and the cable sheath to 0.01-0.04 in. (0.25-1.00mm)

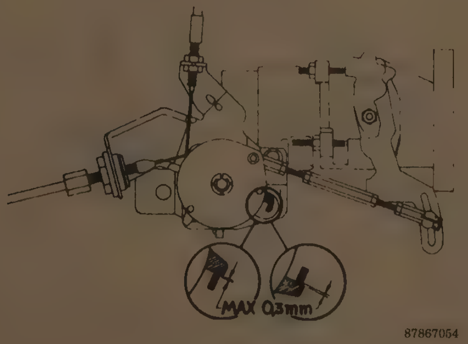


Fig. 66 A maximum clearance of 0.012 in. (0.3mm) is permitted between the pulley and the maximum speed stop.

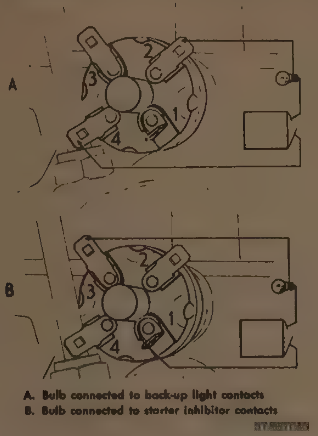

A
B
1
2
3
4
A. Bulb connected to back-up light contacts
B. Bulb connected to starter inhibitor contacts

Fig. 67 Adjust the neutral safety switch for correct operation — 1970-71 models

cal leads. Unscrew the switch until it is held in by just a few threads.

4. On 1970-71 models, connect a 12 volt test light to the back-up light terminals (2 and 4) and screw in the switch until the test light goes out. Disconnect the light and mark this position on the switch and transmission with a pencil. Connect the test light to the start inhibitor terminals (1 and 3) and screw out the switch until the light goes on. Disconnect the light and also mark this position. The proper adjustment is midway between these two marks.
5. On 1972 models, connect a 12 volt test light to start inhibitor terminals (1 and 3), and screw in the switch until the test light goes out. Disconnect the light and mark this position on the switch and transmission with a pencil. Connect the test light to the back-up light terminals (2 and 4) and screw out the switch until the light goes on. Disconnect the light and also mark this position. The proper adjustment is midway between these two marks.
6. When the proper adjustment is achieved, tighten the locknut; take care not to disturb the adjustment. Connect the four electrical leads.
7. On 1972 140 series and 164 models, reinstall the control lever on the transmission.
8. Block the wheels so that the car cannot move either forward or backward. Make sure that the engine can only be started with the gear selector in NEUTRAL or PARK. Make sure that the back-up lights operate only when the selector is placed in REVERSE.

1976 and Later 200 Series Models

➧ See Figure 69

Some early 1976 models have a non-adjustable neutral switch located on the side of the case. All subsequent production models have an adjustable switch, located beneath the shifter quadrant in the tunnel. To adjust:

1. Remove the shifter quadrant cover.
2. Place the shifter lever in PARK. Check that the round switch contact centers over the indicating line for PARK. If not, loosen the two switch mounting screws and align the switch.
3. Place the shifter lever in NEUTRAL. Repeat the check and adjust as necessary.

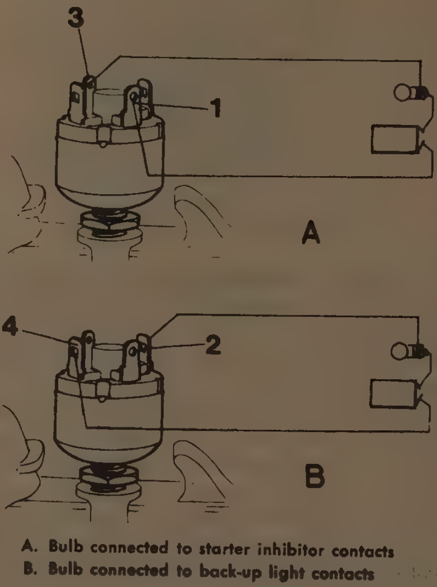

3
1
A
4
2
B
A. Bulb connected to starter inhibitor contacts
B. Bulb connected to back-up light contacts
87867056

Fig. 68 Adjust the neutral safety switch for correct operation — 1972 models

4. If it is necessary to replace the switch, simply remove the two mounting screws and disconnect the wiring connector. Install the new switch and reconnect the wiring.
5. Check that the engine starts only in PARK or NEUTRAL, and that the back-up lights work only in REVERSE.

200 and 700 Series With AW/BW 55, AW70/71 and ZF22 Transmissions.

➧ See Figure 70

1. Remove the ashtray and panel in the center console.
2. For 1982 through 1984 models:
   a. Remove the left half of the selector faceplate. Do this by removing the two screws hidden under the brush.
   b. Remove the non-adjustable switch from the shifter segment. Separate the connector and remove the switch.
   c. Install the new switch and connect the wiring. Make sure that the tab on the shifter enters the slot on the switch. Don't forget the prism which fits onto the top of the new switch.
   d. Press the rubber seal into place and replace the selector faceplate. Install the two screws under the brush.
3. For 1985 and later models:
   a. Remove the faceplate with the gear position symbols.
   b. Remove the non-adjustable switch from the shifter segment. Separate the connector and remove the switch.
   c. Install the new switch and connect the wiring. Make sure that the tab on the shifter enters the slot on the switch. Don't forget the prism which fits onto the top of the new switch.
   d. Reinstall the holder and the shifter faceplate.
4. Install the panel and the ashtray in the center console.

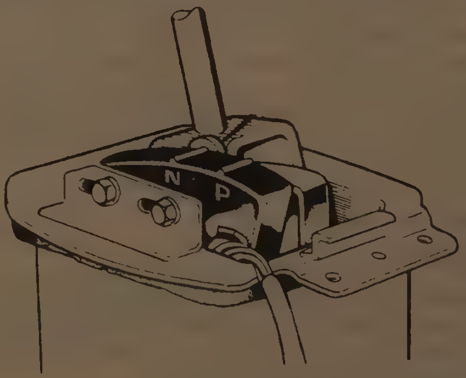


Fig. 69 Make sure the neutral safety switch aligns correctly with the shifter — 1976 and later 200 series with adjustable switches

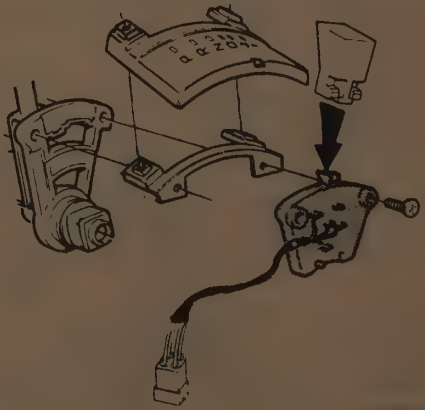


Fig. 70 Exploded view of the shifter, its faceplate and holder — 1985 and later

Automatic Transmission

REMOVAL & INSTALLATION

➧ See Figures 71 and 72

✲✲CAUTION

If the vehicle has been driven within the last 3-5 hours, the transmission oil can be scalding hot. Use extreme care when draining the oil or handling components.

1800 Series

1. Disconnect the battery ground and lift off the windshield washer container.
2. Disconnect the throttle cable from the lever and bracket.
3. Remove the radiator attaching bolts.
4. Raise the vehicle and support front and rear on jackstands.
5. Drain the oil into a clean container.
6. Disconnect the driveshaft from the transmission flange.
7. Disconnect the oil cooler pipes and remove the sump reinforcing bracket.
8. Remove the converter attaching bolts.
9. Place a jack or transmission dolly with holding fixture under the transmission.
10. Remove the shift control rods, shift lever bracket and rear crossmember.
11. Disconnect the front muffler clamp and the speedometer cable from the case.
12. Lower the jack until the filler pipe touches the firewall.
13. Disconnect all electrical connections at the case.
14. Remove the two upper bolts from the converter housing, the filler pipe and the two remaining converter housing bolts.
15. Lower the jack and pull the transmission to the rear to clear the guide pins.

➡The transmission must not be tilted forward or the converter will slide off the input shaft.

16. Install the transmission by balancing it on the jack or dolly and loading it straight onto the engine.
17. Install the two upper bolts for the converter housing, the filler pipe and two of the housing bolts. Torque the converter-to-drive plate bolts to 27 ft. lbs.
18. Connect the wiring to the transmission switches.
19. Elevate the jack and place the transmission in its final position. Install the speedometer cable and secure the front muffler clamp.
20. Install the rear crossmember, the shift lever bracket and the shift control rods. Tighten the crossmember bolts to 18 ft. lbs. (24 Nm). Once the crossmember is secure, the jack may be removed.
21. Install the remaining converter housing bolts, the sump reinforcement and connect the oil cooler pipes.
22. Attach the driveshaft and refill the oil in the transmission.
23. Lower the vehicle from its stands and install the radiator attaching bolts.
24. Attach the throttle cable to the lever and bracket and adjust if necessary.
25. Replace the windshield washer container and attach the negative battery cable.

140 Series

1. Disconnect the negative battery cable. Remove the dipstick and filler pipe clamp.
2. Remove the bracket and throttle cable from the dashboard and throttle control.
3. Disconnect the exhaust pipe at the manifold flange.
4. Raise the car and support on jackstands at the front and rear axles.
5. Drain the fluid into a clean container.
6. Disconnect the driveshaft from the transmission flange.
7. Disconnect the selector lever controls (shift linkage) and the pan reinforcing bracket.
8. Remove the converter attaching bolts.
9. Support the transmission with a jack or a transmission dolly and holding fixture.
10. Remove the rear crossmember.
11. Disconnect the exhaust pipe and rear engine mount brackets.
12. Remove the speedometer cable and filler pipe.
13. Install a wooden block between the engine and firewall; lower the jack until the engine contacts the block.
14. Make sure no tension is put on the battery cable.
15. Disconnect all electrical wiring at the transmission case.
16. Disconnect the starter cable and remove the starter.
17. Remove the converter housing bolts.
18. Pull the transmission backwards to clear the guide pins.
19. When reinstalling, load the transmission straight onto the engine and install the converter housing bolts. Tighten the converter-to-drive plate bolts to 27 ft. lbs. (37 Nm).
20. Install the starter and connect its cable; hook up all other wiring to the transmission case.
21. Using the jack, elevate the transmission and engine into their proper position. Install the speedometer cable and the filler pipe.
22. Reconnect the exhaust pipe and the rear engine mount brackets.
23. Install the rear crossmember and tighten its bolts to 18 ft. lbs. (24 Nm). When the crossmember is secure, the jack may be removed.
24. Install the converter attaching bolts. Connect the selector lever controls and the pan reinforcing bracket.
25. Connect the driveshaft to the transmission flange.
26. Lower the car from its stands and refill the transmission fluid.
27. Reconnect the exhaust pipe at the manifold flange.
28. Reinstall the bracket and throttle cable and adjust if necessary.
29. Install the dipstick and filler pipe.
30. Reconnect the negative battery cable.

164 Models and 1975 240 Series

1. Disconnect the negative battery cable. Remove the dipstick and filler pipe clamp.
2. Remove the bracket and throttle cable from the dashboard and throttle control.
3. Disconnect the exhaust pipe at the manifold flange.
4. Raise the car and support on jackstands at the front and rear axles.

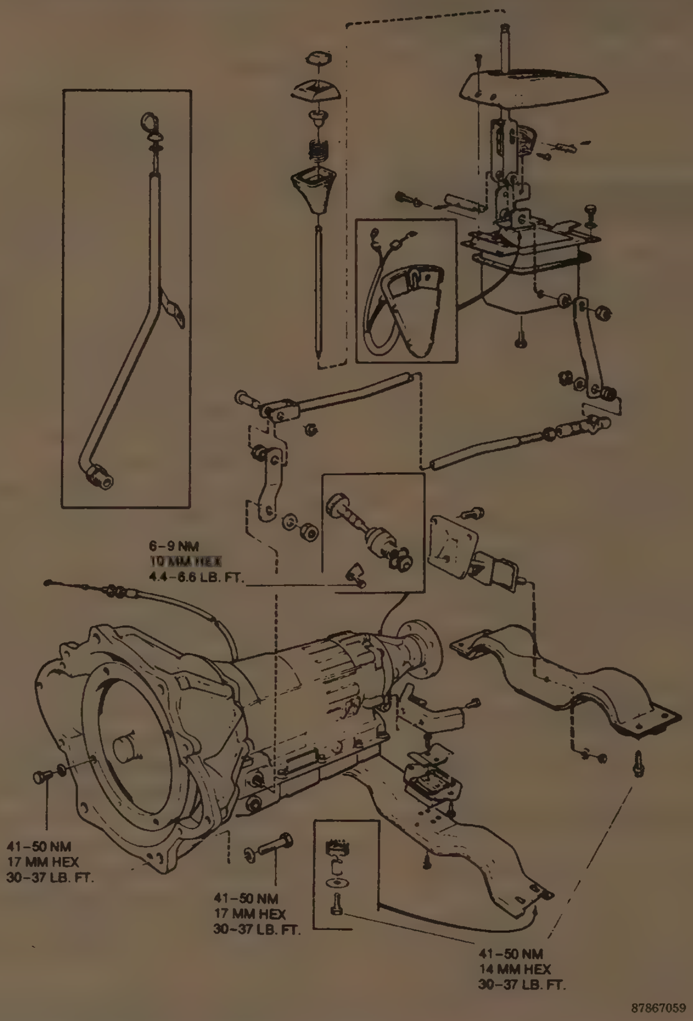


Fig. 71 Exploded view of the BW55/AW55 transmission mounting components — AW70 and AW71 are similar

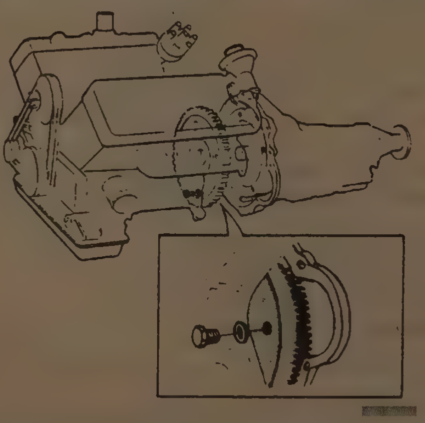


Fig. 72 Access to the coupling flange bolts — AW55, BW 55, AW70 and AW71 transmissions

5. Drain the fluid into a clean container.
6. Disconnect the driveshaft from the transmission flange.
7. Disconnect the selector lever controls (shift linkage) and the pan reinforcing bracket.
8. Remove the converter attaching bolts.
9. Support the transmission with a jack or a transmission dolly and holding fixture.
10. Remove the rear crossmember.
11. Disconnect the exhaust pipe brackets and remove the speedometer cable from the case.
12. Remove the filler pipe.
13. Install a wooden block between the engine and firewall; lower the jack until the engine contacts the block.
14. Make sure no tension is put on the battery cable.
15. Disconnect all electrical wiring at the transmission case.
16. Disconnect the starter cable and remove the starter.
17. Remove the converter housing bolts.
18. Pull the transmission backwards to clear the guide pins.
19. When reinstalling, load the transmission straight onto the engine and install the converter housing bolts. Tighten the converter-to-drive plate bolts to 35 ft. lbs. (47 Nm).

20. Install the starter and connect its cable; hook up all other wiring to the transmission case.
21. Using the jack, elevate the transmission and engine into their proper position. Install the speedometer cable and the filler pipe.
22. Reconnect the exhaust pipe and the rear engine mount brackets.
23. Install the rear crossmember and tighten its bolts to 18 ft. lbs. (24 Nm). When the crossmember is secure, the jack may be removed.
24. Install the converter attaching bolts. Connect the selector lever controls and the pan reinforcing bracket.
25. Connect the driveshaft to the transmission flange.
26. Lower the car from its stands and refill the transmission fluid.
27. Reconnect the exhaust pipe at the manifold flange.
28. Reinstall the bracket and throttle cable and adjust if necessary.
29. Install the dipstick and filler pipe.
30. Reconnect the negative battery cable.

1976 and Later 240 and DL Series

1. Disconnect the negative battery cable. Remove the dipstick and filler pipe clamp.
2. Remove the bracket and throttle cable from the dashboard and throttle control.
3. Disconnect the exhaust pipe at the manifold flange.
4. Raise the car and support on jackstands at the front and rear axles.
5. Drain the fluid into a clean container.
6. Disconnect the driveshaft from the transmission flange.
7. Disconnect the selector lever controls (shift linkage) and the pan reinforcing bracket.
8. Remove the converter attaching bolts.
9. Support the transmission with a jack or a transmission dolly and holding fixture.
10. Remove the rear crossmember.
11. Disconnect the exhaust pipe brackets and remove the speedometer cable from the case.
12. Remove the filler pipe.
13. Install a wooden block between the engine and firewall; lower the jack until the engine contacts the block.
14. Make sure no tension is put on the battery cable.
15. Disconnect all electrical wiring at the transmission case.
16. Disconnect the starter cable and remove the starter.
17. Remove the converter housing bolts.
18. Pull the transmission backwards to clear the guide pins.
19. When reinstalling, load the transmission straight onto the engine and install the converter housing bolts. Tighten the converter-to-drive plate bolts to 35 ft. lbs. (47 Nm).
20. Install the starter and connect its cable; hook up all other wiring to the transmission case.
21. Using the jack, elevate the transmission and engine into their proper position. Install the speedometer cable and the filler pipe.
22. Reconnect the exhaust pipe and the rear engine mount brackets.
23. Install the rear crossmember and tighten its bolts to 18 ft. lbs. (24 Nm). When the crossmember is secure, the jack may be removed.
24. Install the converter attaching bolts. Connect the selector lever controls and the pan reinforcing bracket.
25. Connect the driveshaft to the transmission flange.
26. Lower the car from its stands and refill the transmission fluid.
27. Reconnect the exhaust pipe at the manifold flange.
28. Reinstall the bracket and throttle cable and adjust if necessary.
29. Install the dipstick and filler pipe.
30. Reconnect the negative battery cable.

All 260, GL Series

1. Disconnect the negative battery cable and remove the air cleaner.
2. Disconnect the throttle cable.
3. Remove the two upper converter housing bolts.
4. Remove the filler pipe.
5. Raise the vehicle, support it front and rear with jackstands and drain the transmission oil into a clean container.
6. Remove the splash shield (8 bolts).
7. Disconnect the front muffler from the rubber hanger.
8. Disconnect the driveshaft from the transmission flange.
9. Remove the exhaust pipe brackets at the rear of the transmission.
10. Remove the rear crossmember.
11. Remove the rear engine support and exhaust pipe bracket.
12. Remove the speedometer cable.
13. Disconnect the cooler lines at the transmission.
14. Remove the electrical connections from the transmission.
15. Remove neutral start switch, if mounted on the case.
16. Remove shift control rod.
17. Remove the engine-to-transmission cover plate.
18. Remove the starter motor and cover.
19. Remove the converter-to-drive plate bolts.
20. Position a jack or a transmission dolly with holding fixture under transmission.
21. Remove the two lower converter housing bolts.
22. Pull the transmission back and down to clear the guide pins.
23. When reinstalling , support the transmission on the jack and position at the rear of the engine. Attach the transmission and install and tighten the starter and bolts.
24. Connect the oil filler pipe at the lower end but do NOT tighten the nut yet.
25. Install the upper retaining bolts for the case and tighten them to 35 ft. lbs. (47 Nm). Install the bracket and nuts for the oil filler pipe.
26. Now tighten the lower nut for the oil pipe. Correct torque is 60-70 ft. lbs. (81-95 Nm).
27. Attach the converter to drive plate bolts and torque them to 35 ft. lbs. (47 Nm).
28. Install the cover plate for the alternate starter position. Install the lower cover plate and tighten the bolts only to 5-6 ft. lbs.
29. Move the gear selector into position 2 (second form the front) and attach the front end of the control rod.
30. Attach the rear end of the control rod. Rough adjustments may be done by turning the entire assembly; fine adjustments are done only by turning the serrated sleeve. Maximum visible thread is 1⅛ in. or 29mm.

31. Check the control rod adjustment. The free-play from DRIVE to its forward stop should be the same as from 2 to its rearward stop. Adjust linkage as necessary to establish this free-play.
32. Install the neutral safety switch if it is mounted in the case.
33. Install the oil cooler pipes.
34. Attach the driveshaft to the drive flange on the transmission.
35. Install the exhaust pipe bracket, the rear engine mount and the speedometer cable.
36. Install the transmission crossmember and tighten its bolts to 35 ft. lbs. (47 Nm).
37. Install and tighten the exhaust pipe clamps and the rubber muffler hanger.
38. Install the splash guard under the engine.
39. Attach the throttle cable to the bracket and adjust as necessary. Check the full throttle adjustment; the pulley should touch the stop with the accelerator pedal floored. Adjust the transmission cable as outlined previously in this chapter.
40. Install the air cleaner, fill the transmission with the correct amount of fluid and lower the car to the ground.

700 Series

➧ See Figures 73, 74 and 75

1. Place the gear selector in the PARK position; if equipped with ZF 22, place selector in NEUTRAL.
2. Disconnect the kickdown cable at the throttle pulley on the engine. Disconnect the battery ground cable.
3. Disconnect the oil filler tube at the oil pan, and drain the transmission oil.

✲✲CAUTION

The oil will be scalding hot if the car was recently driven.

4. Disconnect the control rod at the transmission lever, and disconnect the reaction rod at the transmission housing.
5. On the AW 71 transmission, disconnect the wire at the solenoid (slightly to the rear of the transmission-to-driveshaft flange).

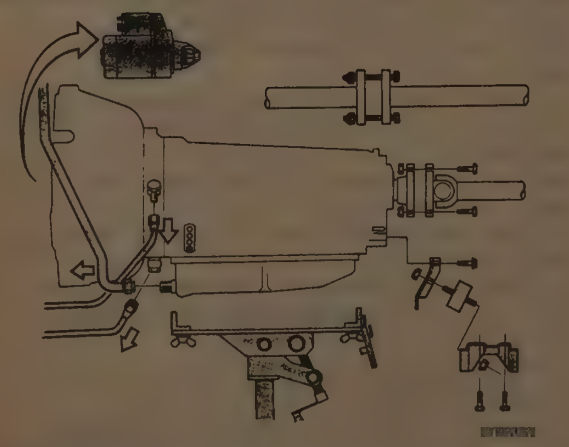


Fig. 73 Remove these external parts from the ZF 22 transmission

6. Matchmark the transmission-to-driveshaft flange and unbolt the driveshaft.
7. Place a jack or transmission dolly under the transmission and support the unit. Remember that the transmission will be heavier at the front end than the rear. Remove the transmission crossmember assembly.
8. Disconnect the exhaust pipe at the joint and remove the exhaust pipe bracket from the exhaust pipe. Remove the rear engine mount with the exhaust pipe bracket.
9. On D24T models, remove the starter motor. On B28F V6 models, remove the bolts retaining the starter motor.
10. Remove the cover for the alternate starter motor location on B28F models. Remove the cover plate at the torque converter housing bottom on B28F models.
11. Disconnect the oil cooler lines at the transmission.
12. Remove the two upper bolts at the torque converter cover. Remove the oil filler tube.

➡It is helpful to have another person steadying and guiding the transmission during the removal process.

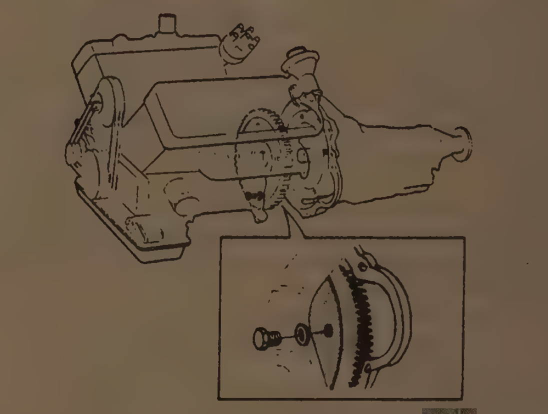


Fig. 74 Access to the coupling flange bolts — AW/BW55 and AW70, AW71 transmissions

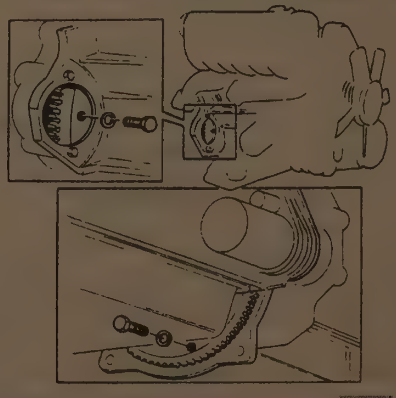


Fig. 75 Access to the coupling flange bolts — ZF 22 transmission. Above: D24 and D24T. Below: B23 and B230

13. Remove the two lower bellhousing screws.

14. Remove the screws retaining the torque converter to the drive plate. Pry the torque converter back from the drive plate with a small pry bar.

15. Slowly lower the transmission as you pull it back to clear the input shaft. Do not tilt the transmission forward, or the torque converter may slide off.

To install:

16. When reinstalling, install the two lower bolts in the casing as soon as the transmission is in place. For B28 motors, adjust the panel between the starter motor and torque converter casing and install the bolts for the starter.

17. Mount the oil filler tube at the oil pan but do not tighten the nut.

18. Install the tube bracket and the two upper bolts in the converter casing. Now tighten the nut for the oil tube to 65 ft. lbs. (88 Nm).

19. Install the bolts for the coupling flange; tighten the bolts hand-tight first, then tighten in a crisscross pattern to 32 ft. lbs. (43 Nm).

20. Reinstall the rear engine mount with the exhaust pipe bracket and reconnect the exhaust system.

21. Reinstall the transmission crossmember; when it is securely bolted in place, the supporting jack may be removed.

22. Reinstall the driveshaft.

23. Making sure that both the transmission linkage and the shift selector in the car are in the PARK position (NEUTRAL for ZF 22 transmission), attach the actuator rod and the reaction rod. Adjust the shift linkage as necessary.

24. On AW71 models, install and connect the wiring to the solenoid valve.

25. Connect the kickdown cable at the throttle pulley. Adjust the cable if necessary.

26. Fill the transmission with oil. Attach the negative battery cable.

DRIVELINE

See Figures 76 and 77

The driveshaft is a two-piece tubular unit, connected by an intermediate universal joint. The rear end of the front section of the driveshaft contains a splined sleeve. A splined shaft forming one of the yokes for the intermediate U-joint fits into this sleeve.

The front section is supported by a bearing contained in an insulated rubber housing attached to the bottom of the driveshaft tunnel. The front section is connected to the transmission flange, and the rear section is connected to the differential housing flange by universal joints.

Each joint consists of a spider with four ground trunnions carried in the flange yokes by needle bearings.

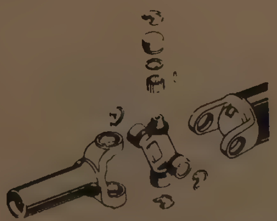


Fig. 76 Design features of a common universal joint

Driveshaft and Universal Joints

REMOVAL & INSTALLATION

See Figures 78, 79 and 80

1. Jack up the vehicle and install jackstands.

2. Mark the relative positions of the driveshaft yokes on the transmission and differential housing flanges for purposes of assembly. Remove the nuts and bolts which retain the front and rear driveshaft sections to the transmission and differential housing flanges. Remove the support bearing housing from the driveshaft tunnel, and lower the driveshaft and universal joint assembly as a unit.

3. Pry up the lock washer and remove the support bearing retaining nut. Pull off the rear section of the driveshaft with the intermediate universal joint and splined shaft of the front section. The support bearing may now be pressed off from the driveshaft.

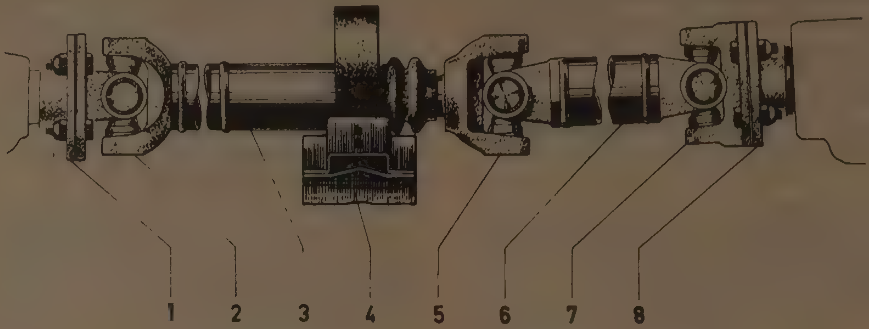
4. Remove the support bearing from its housing.

5. For removal of the universal joints from the driveshaft, consult Universal Joint Overhaul.

6. Inspect the driveshaft sections for straightness. Using a dial indicator, or rolling the shafts along a flat surface, make sure that the driveshaft out-of-round does not exceed 0.010 in. (0.25mm). Do not attempt to straighten a damaged shaft. Any shaft exceeding 0.010 in. (0.25mm) out-of-round will cause substantial vibration, and must be replaced. Also, inspect the support bearing by pressing the races against each other by hand, and turning them in opposite directions. If the bearing binds at any point, it must be discarded and replaced.

7. Install the support bearing into its housing.

8. Press the support bearing and housing onto the front driveshaft section. Push the splined shaft of the rear section (with the intermediate universal joint and rear driveshaft sec-



1. Flange on transmission
2. Front universal joint
3. Front section of propeller shaft
4. Support bearing
5. Intermediate universal joint
6. Rear propeller shaft
7. Rear universal joint
8. Flange on rear axle

Fig. 77 Detailed view of a common driveshaft

tion) into the splined sleeve of the front section. Install the retaining nut and lock washer for the support bearing.

➡Pay particular attention to the placement of the yokes at the end of the shaft. They must be in the same alignment front and rear or driveline vibration will be induced.

9. Taking note of the alignment marks made prior to removal, position the driveshaft and universal joint assembly to its flange and install but do not tighten its retaining nuts and bolts. Position the support bearing housing to the driveshaft tunnel and install the retaining nut. Tighten the nuts which retain the driveshaft sections to the transmission and differential housing flanges to a torque of 25-30 ft. lbs. (34-41 Nm).
10. Remove the jackstands and lower the vehicle. Road test the car and check for driveline vibrations.

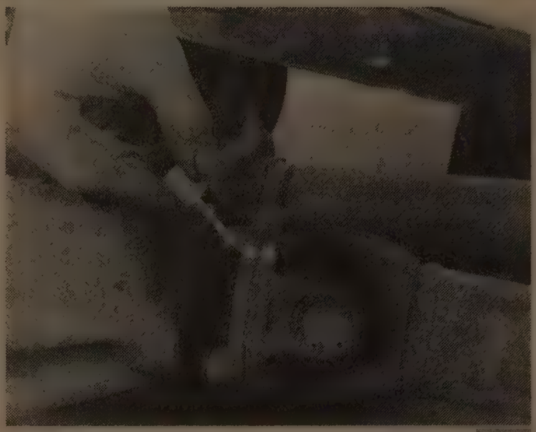


Fig. 78 Use a marker, paint, or (as shown) white correction fluid to matchmark the driveshaft flanges

Fig. 79 Remove the retainers from the front and rear driveshaft flanges — you will need a wrench to hold the nut as you turn the bolt

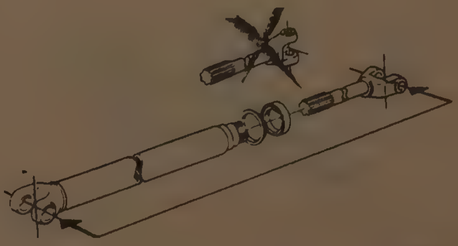


Fig. 80 Make sure the relative placement of the yokes is correct as this is essential to eliminating excessive driveline noise, vibration and harshness

UNIVERSAL JOINT OVERHAUL

See Figures 81, 82, 83 and 84

1. Remove the driveshaft and universal joint assembly as outlined above.
2. Clean off the dirt from the surrounding area and remove the snaprings, which secure the needle bearings in the yokes, with a snapring pliers. If the rings are difficult to loosen, apply rust penetrant and tap the ring lightly with a hammer and punch.
3. Lightly mount the shaft in a vise and adjust its position so that the yoke is supported by the jaws. If at all possible, do not tighten the vise onto the tubular shaft; it can be easily deformed.
4. Using a plastic mallet, tap on the shaft flange until the bearing cup(s) protrude about 0.2 in. (5mm). Do not tap on the tubular shaft.
5. Leaving the flange clamped in the vise, lift the driveshaft and insert a piece of wood or a hammer handle under the shaft. Gently press down on the driveshaft; this will lever the bearing cap upwards. Once all are removed, clean the seats in the driveshaft and flange. Clean the spider and needle bearings completely. Check the contact surfaces for wear. Replace any worn or broken parts. If the old needle bearings and spider are to be reused, fill them with molybdenum disulfide chassis grease, and make sure that the rubber seals are not damaged. If new needle bearings are used, fill them half-way with the grease.
6. Remove the bearing caps and seals from the new spider. Make sure that the needle bearings and seals are in place within the cups.
7. Position the spider into the flange yoke. Place one of the bearing cups on the spider and tap the cup until it is firmly seated.
8. Using the vise and a sleeve of proper size, press the cup into place in the yoke. The cup should project through the yoke about 0.1-0.2 in. (2.5-5.0mm). Install the snapring (circlip). Make sure the spider is centered within the yoke.

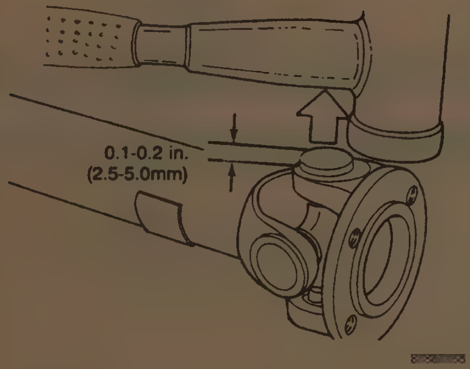


Fig. 81 Gently tap the flange to raise the bearing cup

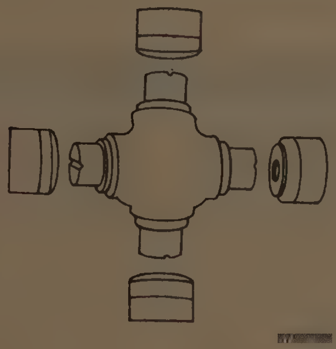


Fig. 83 Make sure the needle bearings are in place inside the cups before installation

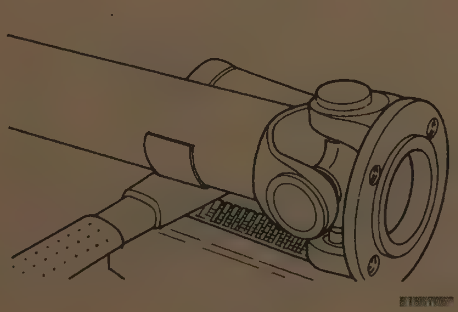


Fig. 82 Press down on the shaft when supported from underneath to further free the bearing cups

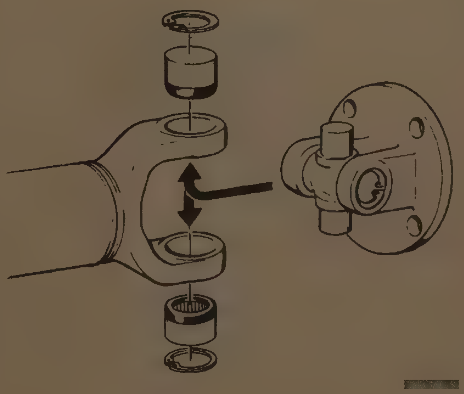


Fig. 84 Position the flange and the new joint into the driveshaft

9. Repeat the previous pressing operation on the opposite side of the flange yoke. Note that when the second bearing cup is pressed into place, the first bearing cup is pressed against its snapring.

10. Fit the spider into the driveshaft yoke. Place and press each bearing cup into place following the procedures above.

11. Release the assembly from the vise. Check the new joint for free motion in all dimensions. If any stiffness or binding is present, remount the assembly in the vise (as described previously) and LIGHTLY tap the spider ends with a plastic mallet.

Center Bearing

REMOVAL & INSTALLATION

See Figure 85

The center support bearing must rotate freely with no noise or binding. It not a serviceable component; if it is noisy or binds it must be replaced. Use of a press with the appropriate blocks and sleeves is required for replacement.

1800 and 140/160 Series

1. Remove the driveshaft as outlined previously.
2. Separate the front and rear shafts and loosen the cover for the support bearing. Remove the complete bearing.
3. Using a press if necessary, remove the bearing from the rubber housing. Before installing the new bearing, make sure all seating surfaces are clean.
4. Install the new bearing into the rubber mount and reassemble the shaft into the bearing.

200 Series

See Figures 86 and 87

1. Remove the front driveshaft and center bearing assembly as outlined above.
2. Press the bearing out of the rubber mount. The bearing will stay attached to the driveshaft.
3. Using a drift or a press if necessary, remove the bearing from the driveshaft. Take care not to damage the dust cover around the bearing.
4. Install the new bearing by pressing it onto the shaft. Install the rubber mount. Observe correct placement of the bearing within the mount.
5. Reassemble the driveshaft halves. If the splines are dry, lightly coat them with grease.
6. When reinstalling the driveshaft and central bearing in the car, check that the spring and washer are positioned correctly in the rubber mount. Also make sure that the bearing is centered in its mounts before final tightening.

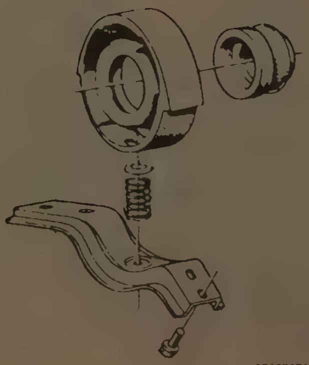


Fig. 85 Exploded view of the driveshaft center bearing

700 Series

See Figure 88

1. Remove the front driveshaft section as outlined above.
2. Remove the protective rubber boot and, using a sleeve of suitable size, mount the shaft in a press and remove the shaft from the bearing assembly.

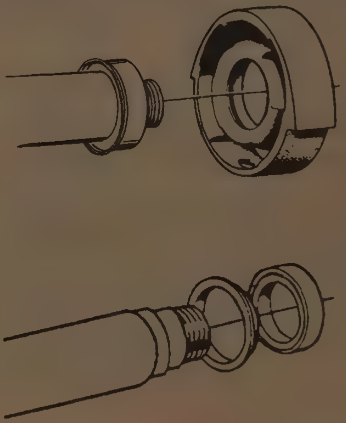
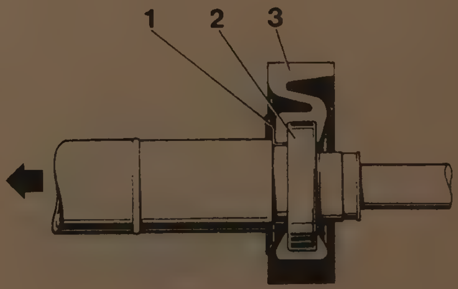


Fig. 86 Disassemble the center bearing and dust cover — 200 series



1. Dust cover
2. Bearing
3. Rubber mount

Fig. 87 Install the bearing correctly in the rubber mount

3. Remove the bearing from the "cage" by using the press and a sleeve.

✲✲WARNING

There are five different types of bearings used on 1980 through 1984 Volvos. When buying the new bearing, have the old one along for comparison and make sure the replacement is identical in every respect.

4. Install the new bearing into the cage. Support the cage as necessary and use a drift when pressing the bearing into place.
5. Tap the protective ring (dust cover) onto the driveshaft, then use the press as needed to install the bearing assembly onto the shaft. Install the rear dust cover, tapping it evenly so that it seats straight.
6. Check the bearing for free motion, silent operation and lack of binding.
7. Install the rubber boot on the back part of the bearing. Lubricate it with a light coat of petroleum jelly. Make sure the boot is properly held in place.

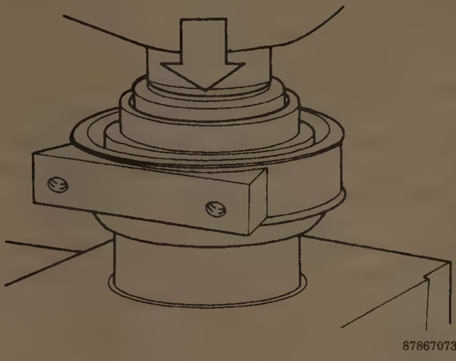


Fig. 88 Press the bearing into the cage as shown — 700 series. Volvo special tools shown

8. Making sure that the yokes are placed in identical positions, reassemble the front and rear driveshaft halves. Install the small rubber boot (if any) on the rear driveshaft section.
9. Reinstall the driveshaft as outlined previously.

REAR AXLE

Understanding Rear Axles

The rear axle is a special type of transmission that reduces the speed of the drive from the engine and transmission and divides the power to the rear wheels. Power enters the rear axle from the driveshaft via the companion flange.The flange is mounted on the drive pinion shaft. The drive pinion shaft and gear which carry the power into the differential turn at engine speed. The gear on the end of the pinion shaft drives a large ring gear the axis of rotation of which is 90° away from the pinion. The pinion and gear reduce the gear ratio of the axle, and change the direction of rotation to turn the axle shafts which drive both wheels. The rear axle gear ratio is found by dividing the number of pinion gear teeth into the number of ring gear teeth.

The ring gear drives the differential case. The case provides the two mounting points for the ends of a pinion shaft on which are mounted two pinion gears. The pinion gears drive the two side gears, one of which is located on the inner end of each axle shaft.

By driving the axle shafts through the arrangement, the differential allows the outer drive wheel to turn faster than the inner drive wheel in a turn.

The main drive pinion and the side bearings, which bear the weight of the differential case, are shimmed to provide proper bearing preload, and to position the pinion and ring gears properly.

➡The proper adjustment of the relationship of the ring and pinion gears is critical. It should be attempted only by those with extensive equipment and/or experience.

Limited-slip differentials include clutches which tend to link each axle shaft to the differential case. Clutches may be engaged either by spring action or by pressure produced by the torque on the axles during a turn. During turning on a dry pavement, the effects of the clutches are overcome, and each wheel turns at the required speed. When slippage occurs at either wheel, however, the clutches will transmit some of the power to the wheel which has the greater amount of traction. Because of the presence of clutches, limited-slip units require a special lubricant.

Determining Axle Ratio

➧ See Figures 89, 90, 91 and 92

The drive axle is said to have a certain axle ratio. This number (usually a whole number and a decimal fraction) is actually a comparison of the number of gear teeth on the ring gear and the pinion gear. For example, a 4.11 rear means that theoretically, there are 4.11 teeth on the ring gear and one tooth on the pinion gear or, put another way, the driveshaft must turn 4.11 times to turn the wheels once. Actually, on a 4.11 rear, there might be 37 teeth on the ring gear and 9 teeth on the pinion gear. By dividing the number of teeth on the pinion gear into the number of teeth on the ring gear, the numerical axle ratio (4.11) is obtained. This also provides a good method of ascertaining exactly what axle ratio one is dealing with.

Another method of determining gear ratio is to jack up and support the car so that both rear wheels are off the ground. Make a chalk mark on the rear wheel and the driveshaft. Put the transmission in neutral. Turn the rear wheel one complete turn and count the number of turns that the driveshaft makes. The number of turns that the driveshaft makes in one complete revolution of the rear wheel is an approximation of the rear axle ratio.

All 1970-87 Volvos use a solid rear axle housing carried in two support arms. Two torque rods, connected between the axle shaft tubes and the body, limit the rear axle wind-up. A track bar (Panhard rod) controls lateral movement of the axle housing. The 760GLE also incorporates a triangulated dual-ladder sub-frame to connect the axle unit to the uni-body.

In 1988, the 760 4 door sedan and the 780 model introduced Volvo's Multi-link suspension system. This independently suspends each rear wheel, allowing improved ride and road-holding as well as allowing each rear wheel to be aligned separately.

Final drive is of the hypoid design, with the drive pinion lying below the ring gear. On the solid axle models, each axle shaft is indexed into a splined sleeve for the differential side gears, and supported at its outer end in a tapered roller bearing. Bearing clearance is not adjustable by use of shims as on earlier model Volvos, but instead is determined by bearing thickness. Both sides of the axle bearings are protected by oil seals.

On vehicles with the Multi-link suspension, the axles are actually halfshafts, bolted to the differential. Each halfshaft has a constant velocity (CV) joint at each end, allowing a full range of motion as the car passes over bumps and depressions.

Some special 1976 and later models are equipped with limited slip differentials for better traction.

The identification plate showing the final drive ratio, the part number and the serial number of the differential can be found on a plate attached to the axle tube or the housing.

Determining Gear Ratio

Determining the axle ratio of any given axle can be a very useful tool to the contemporary car owner. Axle ratios are a major factor in a vehicle's fuel mileage, so the car buyer of today should know both what he or she is looking for, and what the salesperson is talking about. Knowledge of axle ratios is also valuable to the owner/mechanic who is shopping through salvage yards for a used axle, or who is changing ratios by changing rear axles.

The rear axle is said to have a certain ratio, say 4.11. It is called a "4.11 rear" although the 4.11 actually means 4.11 to

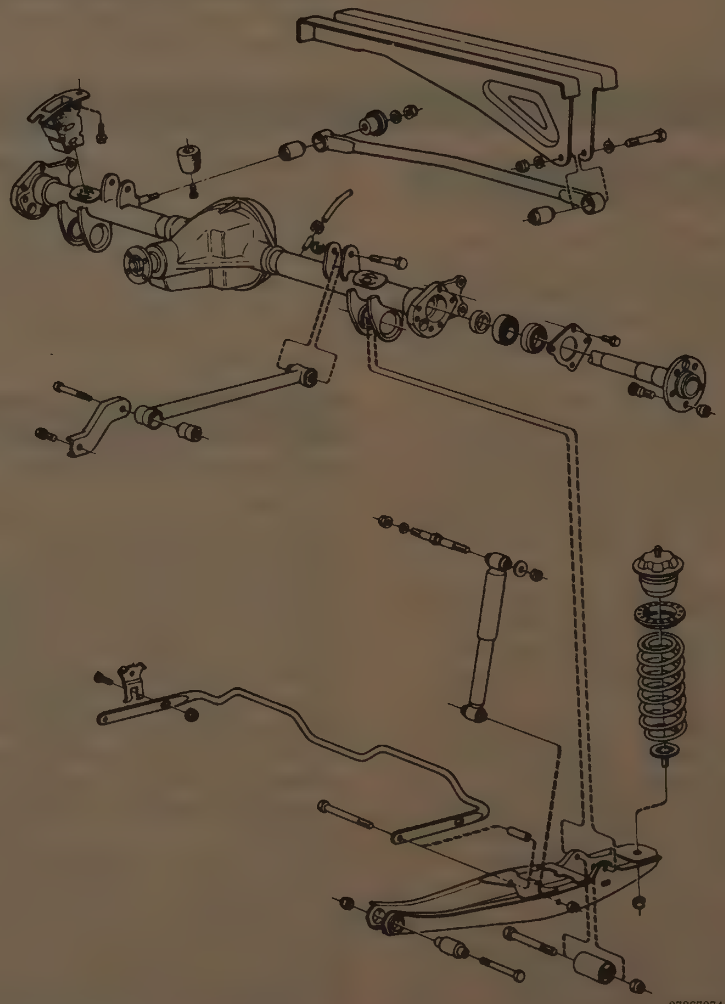


Fig. 89 Exploded view of the rear axle and differential — 240 and 260 series

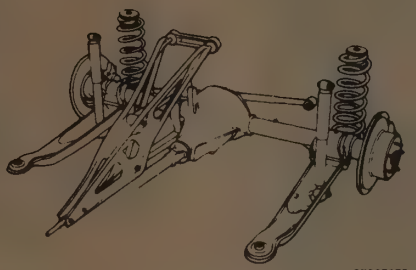
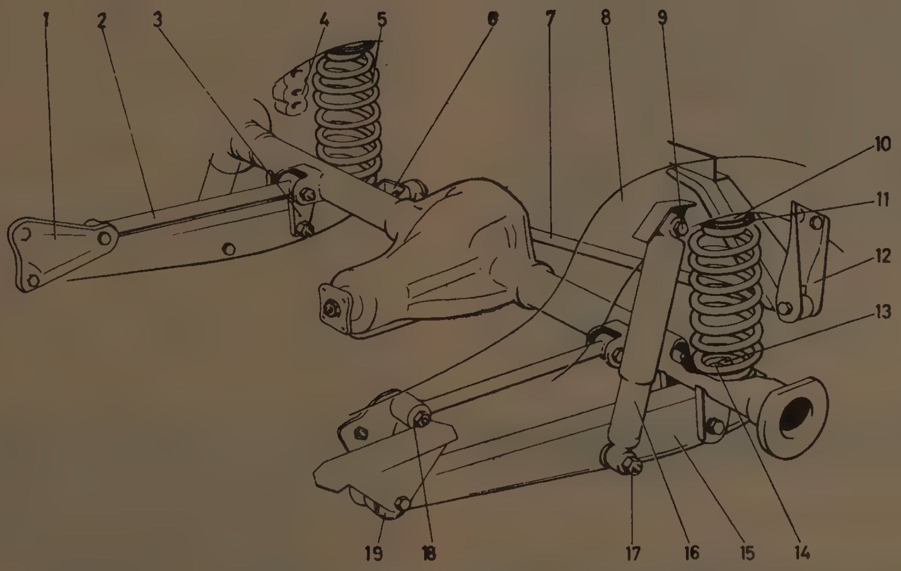


Fig. 90 A common 760GLE series rear axle — the ladder-like assembly above the differential is the sub-frame



1. Bracket
2. Support stay
3. Bracket
4. Rubber buffer
5. Rear spring
6. Bracket
7. Track bar
8. Rear side-member
9. Shock absorber upper attachment
10. Washer
11. Rubber spacer
12. Bracket
13. Screw, lower spring attachment
14. Washer
15. Support arm
16. Shock absorber
17. Shock absorber lower attachment
18. Front support stay attachment
19. Front bushing support arm

Fig. 91 Details of the rear suspension assembly — 140 series and 164 models

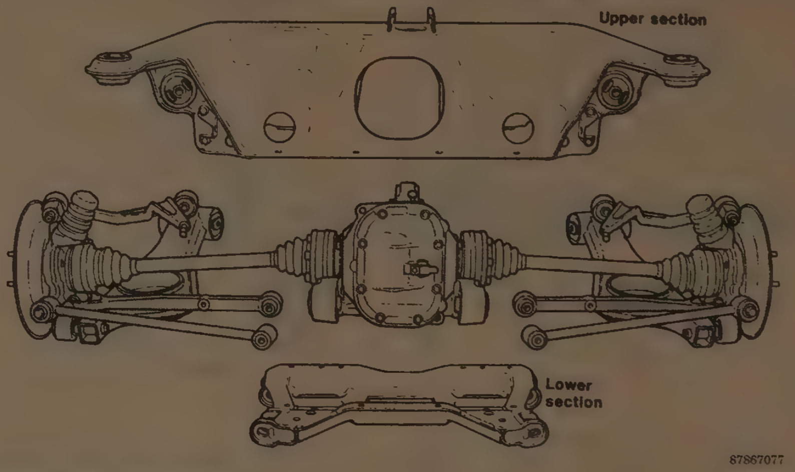


Fig. 92 The Volvo multi-link rear suspension

1 (4.11:1). This means that the driveshaft will turn 4.11 times for every turn of the rear wheels.

The number 4.11 is determined by dividing the number of teeth on the pinion gear into the number of teeth on the ring gear. In the case of a 4.11 rear, there could be 9 teeth on the pinion and 37 teeth on the ring gear (37 divided by 9 = 4.11). Counting the teeth provides a sure way, although troublesome, of determining the ratio for your car. The axle must be drained and the rear cover removed to do this, and then the teeth counted.

A much easier method is to jack up the car and safely support it with jackstands, so BOTH rear wheels are off the ground. Block the front wheels and put the transmission in NEUTRAL. Make a chalk mark on the rear wheel and one on the driveshaft. Turn the rear wheel exactly one revolution and count the number of turns that the driveshaft makes. (Having an assistant to count one or the other is extremely helpful). The number of turns the driveshaft makes in one complete revolution of the rear wheel is a close approximation of the rear axle ratio.

Axle Shaft, Bearing and Oil Seal

REMOVAL & INSTALLATION

✲✲CAUTION

This procedure requires removal of the rear brake pads or shoes. Brake pads and shoes may contain asbestos, which has been determined to a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling and dust from brake surfaces! When cleaning brakes, use commercially available brake cleaning fluids.

All Except Multi-link Suspension

◆ See Figures 93, 94, 95, 96, 97 and 98

1. Raise the rear of the vehicle and support it on jackstands.
2. Remove the applicable wheel.
3. If equipped with drum brakes, remove the shoes, springs and hardware. If equipped with disc brakes:
    a. On models through 1975, place a wooden block beneath the brake pedal, plug the master cylinder reservoir vent hole, then remove and plug the brake line from the caliper. Be careful not to allow any brake fluid to spill onto the disc or pads. Remove the two bolts which retain the brake caliper to the axle housing, and lift off the caliper. Lift off the brake disc.
    b. On 1976 and later models, detach the brake line and bracket from the rear axle, then remove the mounting bolts and remove the caliper. Use a piece of stiff wire to hang the caliper, with brake line still attached, out of the way. Do not allow the caliper to hang by the brake line. Release the parking brake shoes as explained in Chapter 9.
4. On all models, remove the thrust washer bolts through the holes in the axle shaft flange. Using a puller (slide hammer), remove the axle shaft, bearing and oil seal assembly. If a slide hammer is not available, you have a couple alternatives. The first option is the brake disc may be bolted onto the axle backwards (remember to mount the nuts tapered side out) and used to pull the axle free. Or you may use a crow bar with its fulcrum set on a sturdy part of the dust shield to push from behind the axle. Be careful not to bend the dust shield. Use of a wood block to distribute the force (see photos).
5. Remove the inner oil seal (1974-on) with a suitable puller or small prybar.
6. Using a press, remove the axle shaft bearing and its locking ring from the axle shaft. Remove and discard the old oil seal.

➡Some 700 series axles contain a toothed wheel used for sending speed data to the engine and other systems. This wheel must be removed in a press before removing the axle bearing and seal.

7. The new bearing must be packed with grease before installation. The preferred method is with a bearing packer (a low cost tool available at most automotive supply shops) but it may be done by hand if necessary. The bearing must be packed from one side until the grease comes out the other

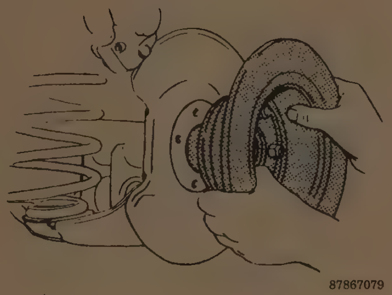


Fig. 93 The brake disc may be bolted onto the axle backwards (with the nuts tapered side out) and used to pull the axle free

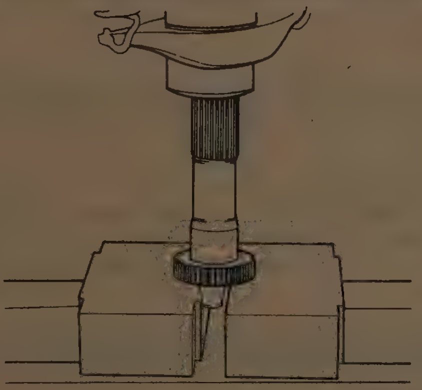


Fig. 94 Remove the data sending wheel before attempting to remove the axle bearing and seal — certain 700 series models

Fig. 95 Remove the bolts securing the drive axle at the wheel hub

Fig. 96 If a slide hammer is not available, you may opt to push the it from behind with a long prybar

Fig. 97 Have rags handy to contain the oil that will slop out with the axle upon removal

side. It is very important that the bearing be completely packed with grease before installation.

8. Fill the space between the lips of the new oil seal with wheel bearing grease. Position the new seal on the axle shaft. Using a press, install the bearing with a new locking ring, onto the axle shaft.

****WARNING**

When reinstalling the additional toothed gear on axles for 700 series, the gear must be installed precisely 116mm onto the shaft. The acceptable margin is ONLY plus or minus 0.1mm. If at all possible, use Volvo tool No. 2412 which will allow precise location of this gear. If this gear is not properly located, the car may not run properly.

9. Install the inner oil seal (1974-on) in the axle shaft housing using a seal installation tool (such as Volvo No. 5009 or similar) and drift.

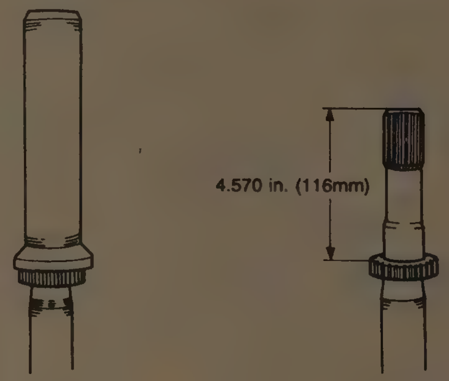


Fig. 98 The gear placement is critical with only a minimal margin for variance. If possible, use the Volvo tool No. 2412 shown

10. Install the axle shaft into the housing, rotating it so that it aligns with the differential. Install the bolts for the thrust washer and tighten to 36 ft. lbs.
11. Install the brake disc, caliper and pads. If equipped with drum brakes, reinstall the shoes, springs and hardware.
12. Install the wheel and lower the car to the ground. Retighten the lug nuts with the car on the ground.

Vehicles With Multi-link Suspension

➧ See Figures 99 and 100

Because of the nature of the Multi-link suspension, component position and bolt tightening values (torque) are critical to ride quality and rear wheel alignment. When installing components, exact location must be achieved--close doesn't count. Tightening specifications must be followed exactly or component function will be impaired.

✲✲WARNING

The use of the correct special tools or their equivalent is REQUIRED for this procedure.

1. Safely elevate the car on jackstands. Make sure the rear stands don't interfere with any of the suspension arms.
2. Remove the wheel on the appropriate side. Remove the brake caliper mounting bolts and use a piece of wire to hang the caliper out of the way.
3. Mark the position of the brake disc relative to its small locating pin, then remove the disc. Remove the brake shoes.
4. Disconnect and remove the handbrake cable from the wheelbearing housing.
5. Remove the retaining bolt for the support arm at the housing. Tap the support arm loose.
6. Remove the nut and bolt holding the lower link arm to the housing.
7. Remove the retaining bolt for the track rod (Panhard rod) at the bearing housing and use a small claw-type puller to remove the track rod.
8. Loosen and remove the large nut holding the end of the driveshaft within the bearing housing.

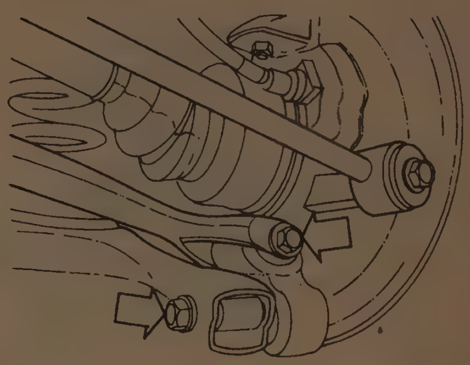


Fig. 99 Remove the support arm bolt (upper arrow) and the lower link bolt (lower arrow)

9. Remove the retaining nut for the upper link at the bearing housing. The wheel bearing housing can now be removed as a unit.

➡There are shims between the bearing housing and the upper link arm. Collect them when the housing is removed.

10. Mount the housing assembly in a vise. Using Volvo tool No. 5340 or similar, apply a counterhold between the hub and bearing housing. Press out the hub with a proper sized drift.
11. With the hub removed, the circlip holding the bearing in the housing can be removed. Press the bearing out of the housing.
12. Use a bearing puller (such as Volvo No. 2722 or similar) and a counterhold (Volvo No. 5310 or similar) to pull the inner ring off the hub.
13. To reinstall, press in the new bearing using a drift and counterhold and install the circlip.
14. Using a counterhold below the inner ring, press the hub into place.

✲✲WARNING

If the counterhold (support) is not used, the wheel bearing will be destroyed during the hub installation.

15. Install the wheel bearing housing onto the driveshaft and install the driveshaft retaining nut. Get the nut secure but don't try to torque it--that will be done later.
16. Install the shims between the upper link and the wheel bearing housing and then install the retaining nut at the upper link.
17. Pull the wheel bearing housing outwards at the top and tighten the upper link arm nut to 85 ft. lbs. (115 Nm). This pulling out is essential to insure correct wheel alignment when completed.
18. Tilt the bearing housing outwards at the bottom (as necessary) to refit the lower link arm and it retaining bolt. When in place, pull the bottom of the bearing housing inwards (towards the center of the car) and tighten the link arm to 36 ft.lbs. PLUS an additional 90° of rotation.

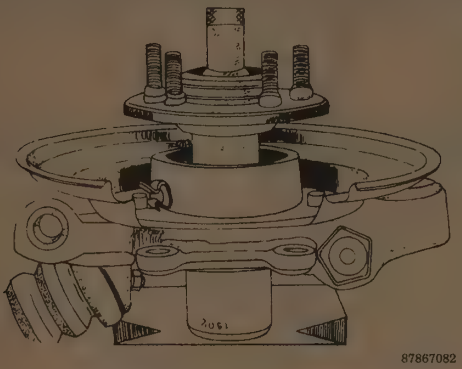


Fig. 100 Use the correct tools when installing the hub. Volvo tools are shown in place above and below the hub

19. Install the support arm and its bolt. Tighten the nut to 44 ft. lbs. (60 Nm) PLUS an additional 90° of rotation.
20. Install the track rod (Panhard rod) and tighten to 63 ft. lbs.
21. Reinstall the handbrake cable at the bearing housing.
22. Reinstall the brake shoes, the brake disc as marked and the brake caliper. Tighten the caliper mounting bolts to 44 ft. lbs.
23. Install the wheel, tightening the lugs to 60-62 ft. lbs. (81-84 Nm). Lower the car to the ground.
24. Tighten the driveshaft nut to 103 ft.lbs (140 Nm) PLUS 60° of rotation.

Halfshafts

REMOVAL & INSTALLATION

700 Series With Multi-link Suspension

➧ See Figure 101

1. Loosen the lug nuts for the appropriate wheel. Loosen the large halfshaft retaining nut in the center of the wheel bearing housing.
2. Block the front wheels and safely elevate and support the rear of the car.
3. Remove the wheel and remove the halfshaft retaining nut.
4. At the center of the car, remove the eight bolts holding the upper and lower sections of the final drive housing.
5. Remove the bolts holding the halfshaft to the final drive unit (differential) and remove the shaft from the wheelbearing housing.
6. When the shaft is removed, inspect the rubber boots for any sign of splitting or cracking. The boots must be intact and waterproof or the joint within is at risk. A light coat of silicone or vinyl protectant applied to a CV boot will extend its life.
7. When reinstalling, fit the threaded end (at the wheel) first, then position and secure the inboard end. Always use new, lightly oiled bolts and tighten them to 70 ft. lbs. (95 Nm).

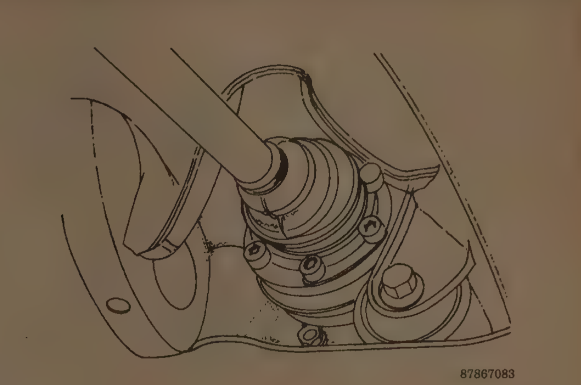


Fig. 101 Unbolt the halfshaft from the final drive unit (differential) and remove the shaft from the wheelbearing housing

8. Reinstall the lower section of the final drive housing. Before tightening the eight mounting bolts, install two long 12mm bolts (or two 12mm drifts) in the centering holes and align the panel. This is essential to insure correct wheel alignment when finished.
9. Tighten the eight mounting bolts to 52 ft. lbs. (71 Nm) PLUS 30° of rotation.
10. Use a new, lightly oiled halfshaft retaining nut and install it on the threaded end of the shaft. Tighten it until it is snug but do not attempt to apply final tightening.
11. Install the wheel, tightening the lugs to 60-62 ft. lbs. (81-84 Nm). Lower the car to the ground.
12. Apply the hand brake and tighten the halfshaft nut to 103 ft. lbs. (140 Nm) PLUS 60° of rotation. Double check the wheel lugs for correct tightness.

Pinion Seal

REMOVAL & INSTALLATION

All Models Except Those Equipped With Multi-link Suspension

➧ See Figure 102

1. Disconnect the driveshaft at the final drive unit (differential).
2. Loosen and remove the large center nut in the center of the pinion flange. The use of a counterhold device is highly recommended. (Volvo No. 5149 or similar)
3. Use a puller to remove the flange from the housing.
4. Remove the old seal from the inside of the casing and discard it. Prepare the new seal by greasing the lip area and greasing the small spring to hold it in place during installation.

To install:

5. Install the seal using suitable drivers; do not crimp or gouge the seal during installation.
6. With an installation tool (Volvo No. 5156 or similar), reinstall the flange in the housing.

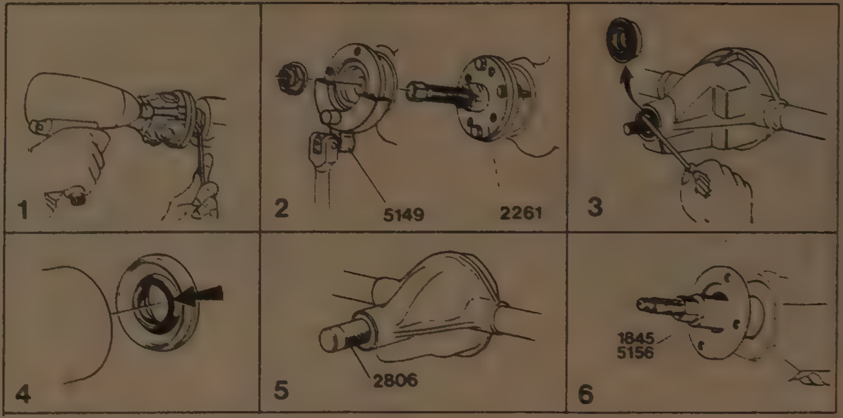


Fig. 102 In sequence: the pinion seal is removed and installed as shown — if air tools are not available, a ratchet and socket will work

7. Check the serial number on the rear axle. If it begins with an "S", follow step 7b, below. If it does NOT contain an S prefix, continue with 7a below.

a. Install the center nut and tighten it to 145-180 ft. lbs. (197-244 Nm). Use a counterhold to hold the flange while tightening.

b. Axles denoted by the S prefix in their serial number contain a compression sleeve within the differential housing. On these cars, install the center nut and carefully tighten it to 1.3 ft. lbs.(finger tight only). Make sure that the brakes are not applied and turn the flange at about 1 revolution per second so as to tighten the nut. As an alternative, the nut may be tightened with a wrench to at least 130 ft. lbs. (176 Nm).

8. Reinstall the driveshaft. Check the oil level within the final drive and top up as necessary.

Vehicles With Multi-link Suspension

See Figure 103

1. Matchmark the driveshaft flange and the final drive (differential) flange. Remove the bolts and separate the shaft from the final drive.

2. Loosen and remove the large center nut in the center of the pinion flange. The use of a counterhold device is highly recommended. (Volvo No. 5149 or similar). Remove the one additional bolt from the flange. This bolt is a weight which serves to balance the rotational forces of the driveshaft.

3. Matchmark or etch reference marks on the flange and its center shaft.

4. Drain the oil from the housing.

5. Use a puller to remove the flange from the housing.

6. Remove the old seal from the inside of the casing and discard it. Prepare the new seal by greasing the lip area and greasing the small spring to hold it in place during installation. The use of a seal puller such as Volvo No. 5069 is highly recommended.

7. Install the seal using suitable drivers; do not crimp or gouge the seal during installation.

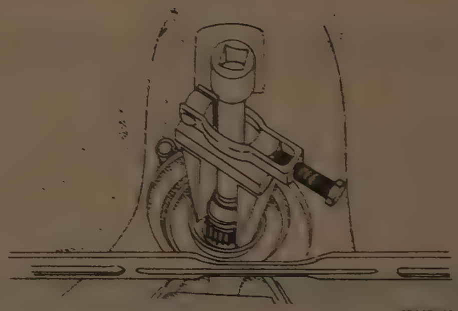


Fig. 103 Use a bearing puller to properly withdraw the seal — Volvo tool No. 5069 is shown

8. Position the flange so that the marks align. With an installation tool (Volvo No. 5156 or similar), reinstall the flange in the housing.

9. Install a new, lightly oiled center nut and tighten it to 132-145 ft. lbs. (179-197 Nm).

WARNING

Do not overtighten the center nut. The pinion bearings will become over-adjusted and fail prematurely.

10. Install the bolt for weight in its original position.

11. Install the driveshaft, observing correct placement as shown by the matchmarks. Use new nuts and bolts and tighten them to 36 ft. lbs. (49 Nm).

12. Refill the final drive unit with oil.

Axle Housing — Complete Unit

REMOVAL & INSTALLATION

****WARNING**

This operation requires removal of a substantial amount of weight from the rear of the car. The vehicle may become front heavy; make sure that floorstands or lifting arms are properly positioned to support the vehicle with the rear axle removed. The use of an axle cradle or two floor jacks is required. Because of the size and weight of the axle assemble, it cannot be safely controlled and supported on a single jack.

1800 Series and 140/160 Series

1. Elevate the car and support it firmly with stands. Do not place the stands in the area of the axle or rear suspension. Locate the stands at the jack points on the body or on the frame. With the car elevated and securely supported, remove the rear wheels.
2. Using the jacks or cradle, elevate the rear axle slightly--just enough to take the tension off its upper mounts. Loosen and remove the upper attaching bolts for the shock absorbers.
3. Disconnect the handbrake cables from the levers and brackets on the backing plates.
4. Disconnect the driveshaft from the flange on the pinion.
5. Remove the brake pipe connector from the rear axle housing. Plug the open lines.
6. Loosen the front attaching bolts for the support arms about one turn. Unscrew the rear bolts for the torque rods.
7. Remove the track rod (Panhard rod) from its mount on the rear axle case and remove the lower attaching bolts for the springs.
8. Lower the jacks or cradle until the support arms release from the springs. Loosen the bolts holding the rear axle to the support arms.
9. Lower the jacks or cradle and remove the axle assembly by pulling it forwards.
10. When reinstalling, position the unit on its jacks or cradle in place under the car. Loosely reconnect the bolts for the support arms and torque rods.
11. Elevate the axle assembly until the track rod mount on the axle is at the same height as the attachment on the body. Install the track rod and secure its bolts.
12. Install the attaching bolts for the springs. Tighten the nuts for the support arms and torque rods.
13. Remove the plugs and reinstall the brake lines and retainers to the axle housing. Carefully connect the lines.
14. Attach the driveshaft to the pinion flange.
15. Install the upper bolts for the shock absorbers. Reinstall the handbrake cables into the brackets and levers.
16. Double check all nut and bolt attachments. If all are secure and tightened, the jacks or cradle may be slowly lowered and removed from the area.
17. Bleed the brake system and adjust the handbrake.
18. Reinstall the rear wheels and lower the vehicle to the ground.
19. Tighten the wheel lugs to 70-100 ft. lbs. (95-135 Nm)

240/260 Series

See Figure 104

1. Elevate the car and support it firmly with stands. Do not place the stands in the area of the axle or rear suspension. Locate the stands at the jack points on the body or on the frame. With the car elevated and securely supported, remove the rear wheels.
2. Remove the rear axle vent hose and the brake line brackets. Do not loosen any brake lines; they will be left intact.
3. Remove the brake calipers and secure them to the upper spring mount with a piece of stiff wire.
4. Remove the brake discs and parking brake shoes.
5. Remove the thrust washer bolts through the holes in the axle shaft flange. Using a puller (slide hammer), remove the axle shaft, bearing and oil seal assembly. If a slide hammer is not available, the brake disc may be bolted onto the axle backwards (remember to mount the nuts tapered side out) and used to pull the axle free.
6. Position the jacks or cradle below the rear axle so that the axle is supported but not elevated.
7. If the exhaust system runs under the axle housing, disconnect the first joint forward of the axle, disconnect any hangers or brackets behind the axle and remove the rear section of the exhaust system.
8. Disconnect the two reaction rods which run from the top of the axle housing to the bodywork.
9. Disconnect the panhard rod from the rear axle.
10. Loosen and remove the bolts attaching the driveshaft to the pinion flange.
11. Separate the handbrake cables from the rear axle.
12. Remove the bolts which hold the lower mount of the shock absorber. Then remove the adjacent bolt which holds the anti-roll bar (sway bar).
13. Loosen, but do not remove, the trailing arm bolts at the front of the trailing arm. Lower the jacks or cradle and allow the axle assemble to pivot downwards on the trailing arms. When clear of the car and well supported on the jacks or cradle, remove the trailing arm mounts at the axle housing. Remove the axle assembly from under the car.

To install:

14. When reinstalling, position the axle unit under the vehicle and attach the trailing arm mounts. Tighten the bolts only enough to hold and still allow motion.
15. Elevate the rear axle and align the springs to their upper mounts. Install the anti-roll bar bolts and the bolts for the lower shock absorber mounts
16. Attach the torque rods to their mounts and attach the Panhard rod to its mount. Tighten these bolts only enough to hold and still allow motion.
17. Replace the handbrake cable brackets.
18. Install the driveshaft to the pinion flange and secure the bolts.
19. If the rear exhaust section was removed, reinstall it.
20. Reinstall the axles in their housings and secure the thrust washer bolts.
21. Install the parking brake shoes, the brake discs and the brake calipers. Tighten the caliper mounting bolts to 42 ft. lbs. (57 Nm).
22. Replace the wheels and lower the vehicle to the ground. Tighten the wheel lugs to 83 ft. lbs. (112 Nm).

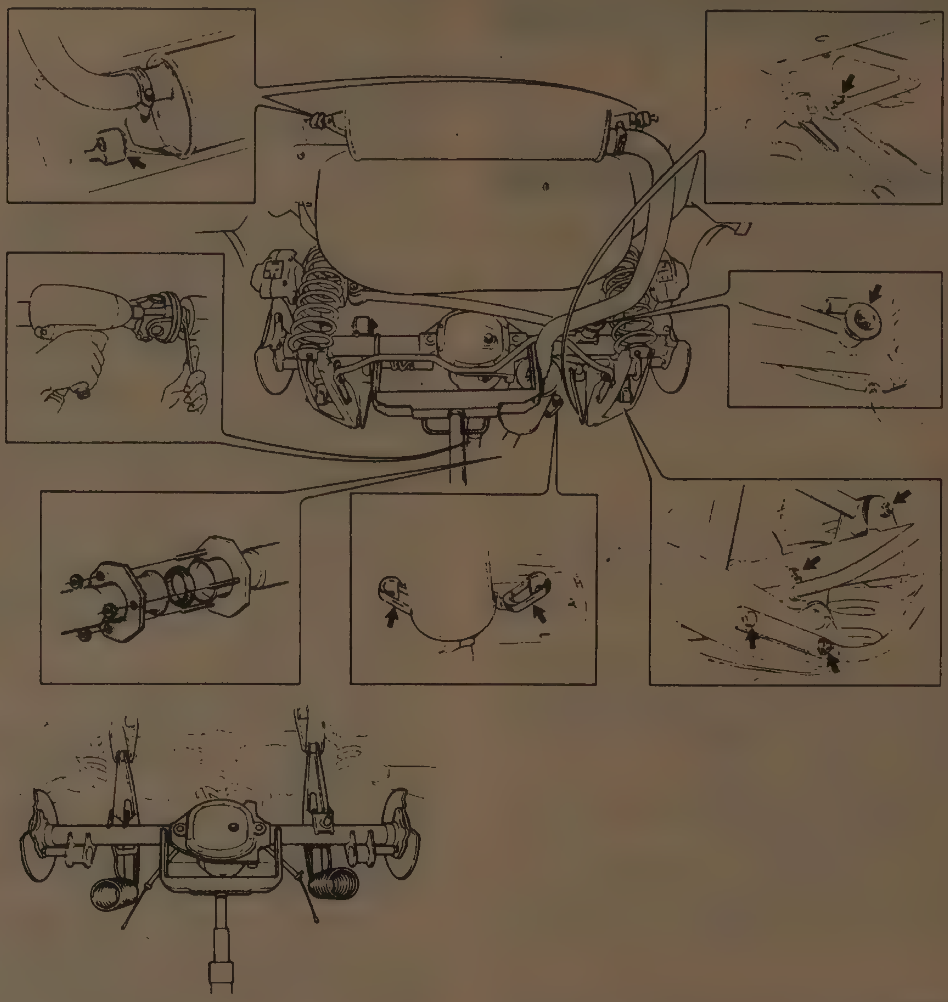


Fig. 104 Remove the axle by detaching the above components — 240 and 260 series models

23. With the weight of the vehicle on the wheels, tighten the bolts at the torque rod-to-axle mount, the panhard rod-to-axle mount and the front mounts of the trailing arms.

740/760 Series Without Multi-link Suspension

1. Elevate the car and support it firmly with stands. Do not place the stands in the area of the axle or rear suspension. Locate the stands at the jack points on the body or on the frame. With the car elevated and securely supported, remove the rear wheels.
2. Remove the brake calipers and secure them to the upper spring mount with a piece of stiff wire.
3. Remove the brake discs and parking brake shoes. Disconnect the cables from the parking brake levers and remove the bolts for the pressure plate.
4. Remove the parking brake cable and the mounting brackets on the rear axle.
5. Position the jacks or cradle below the rear axle so that the axle is supported but not elevated.
6. Remove the thrust washer bolts through the holes in the axle shaft flange. Using a puller (slide hammer), remove the axle shaft, bearing and oil seal assembly. If a slide hammer is not available, the brake disc may be bolted onto the axle backwards (remember to mount the nuts tapered side out) and used to pull the axle free.
7. Disconnect the lower torque rod from the rear axle housing.
8. Raise the jacks or cradle slightly. If the exhaust system runs under the axle housing, disconnect the first joint forward of the axle, disconnect any hangers or brackets behind the axle and remove the rear section of the exhaust system.
9. Disconnect the Panhard rod from the rear axle.
10. Remove the connector for the speedometer transmitter and, if equipped, the connectors for the ETC system.
11. Loosen and remove the bolts attaching the driveshaft to the pinion flange.
12. Remove the upper torque rod from the rear axle.
13. Remove the bolts which hold the lower mount of the shock absorber.
14. Double check that the axle is firmly supported by the jacks or cradle. Remove the front brackets for the support

arms. Pry the support arms loose from the front mounts and remove the rear axle assembly from under the car.

15. Once the axle assembly is clear of the car, remove the anti-roll bar (sway bar). Mark the support arms for the left and right sides and remove the arms from the axle housing. When reinstalling, make sure the left and right markings are observed. Fit the bushings within the clamps and fit the clamps.

16. Tighten the clamps in a crisscross pattern to 33 ft. lbs. (45 Nm) and reinstall the anti-roll bar if so equipped.

17. Position the axle on its jacks or cradle and elevate it so the support arms align with both their front mounts and the spring seats.

18. Install the front brackets for the support arms and tighten the two bolts to 35 ft. lbs. (47 Nm). Tighten the nut to 62 ft. lbs. (84 Nm).

19. Install the lower shock absorber bolts and tighten to 62 ft. lbs. (84 Nm).

20. Reinstall the driveshaft to the pinion flange. Connect the wiring for the ETC sensor and/or the speedometer sensor.

21. Attach the Panhard rod to the axle and tighten it to 62 ft. lbs. (84 Nm).

22. Reinstall the exhaust system as necessary. It will be helpful to elevate the axle to gain clearance.

23. Reinstall the upper torque rod but do not tighten it now.

24. Loosely fit the lower torque rod to its frame. If you loosen the frame to position the bolts, the frame must be tightened before the rod bolts are tightened.

25. Reinstall the parking brake cable to the brake levers. Check the boots at the backing plates.

26. Replace the axles.

27. Reinstall the parking brake shoes, the brake discs and the brake calipers. Tighten the caliper mounting bolts to 42 ft. lbs.

28. Install the rear wheels, remove the jacks or cradle and lower the car to the ground.

29. With the weight of the car on the ground, tighten both torque rods (upper and lower) to 100 ft. lbs. (135 Nm). If this is not done with the axle loaded, the bushings will turn when the axle moves up or down.

30. Adjust the parking brake cable. Check the oil level in the axle housing and top up as necessary.

760/780 With Multi-link Suspension

See Figures 105 and 106

Because of the nature of the Multi-link suspension, component position and bolt tightening values (torque) are critical to ride quality and rear wheel alignment. When installing components, exact location must be achieved--close doesn't count. Tightening specifications must be followed exactly or component function will be impaired.

1. Elevate the car and support it firmly with stands. Do not place the stands in the area of the axle or rear suspension. Locate the stands at the jack points on the body or on the frame. With the car elevated and securely supported, remove the rear wheels.

2. On one side only, remove the bolt holding the support arm to the wheel bearing housing. Drive out the support arm.

3. Remove the nut and bolt holding the lower link arm to the wheel bearing housing.

4. Remove the bolts holding the track rod (Panhard rod) to the wheel bearing housing. Use a puller and a long bolt to move the rod away from the housing.

5. Remove the eight bolts joining the upper and lower sections of the rear axle housing.

6. Swing the lower part of the wheel bearing housing outwards and swing down the lower part of the axle housing. It will still have the two arms attached to it and will be attached to the car by the arms on the opposite side.

7. Matchmark the flanges at the rear of the driveshaft. Remove the four bolts and lower the driveshaft.

8. Place a jack or cradle under the center of the final drive (differential) unit. Elevate the jack and support the unit.

9. Remove the three bolts holding the final drive to the upper housing.

10. Lower the final drive slightly. Remove the wiring to the impulse sender.

11. Remove the bolts holding the axles to the final drive. Carefully lower the final drive unit and remove it from under the car.

12. When reinstalling, raise the final drive unit almost to its final position under the car and connect the impulse sender cable. Tighten the bolt to 7 ft. lbs. (9.5 Nm).

13. Raise the unit to its final position and install the three bolts to the upper housing. Tighten the bolts to 117 ft. lbs. (159 Nm). When the bolts are secure, the jack or cradle may be removed.

14. Attach the halfshafts to the final drive. Tighten the bolts to 22 ft. lbs. (30 Nm) PLUS 90°of rotation.

15. Remount the driveshaft to the pinion flange, tightening the bolts to 36 ft. lbs. (49 Nm). Remember to observe the matchmarks made earlier and position the driveshaft properly.

16. Raise the lower section of the axle housing. Loosely install the eight bolts which retain it to the upper housing. Before tightening the eight mounting bolts, install two long 12mm bolts (or two 12mm drifts) in the centering holes and align the panel. This is essential to insure correct wheel alignment when finished.

17. Tighten the eight bolts to 52 ft. lbs. (71 Nm) PLUS an additional 30° of rotation.

18. Position and install the lower link arm on the wheelbearing housing. Before tightening the nut and bolt, pull the housing in towards the center of the car. When all the play is out of the mount, tighten the link bolt to 36 ft. lbs. (49 Nm) PLUS 90° of rotation.

19. Reconnect the support arm and tighten its bolt to 44 ft. lbs. (60 Nm) PLUS 90° of rotation.

20. Install the track rod and tighten to 62 ft. lbs. (84 Nm).

21. Install the wheels and lower the car from its stands. Tighten the wheels to 62 ft. lbs. (84 Nm). Check the oil level in the final drive and top up as necessary.

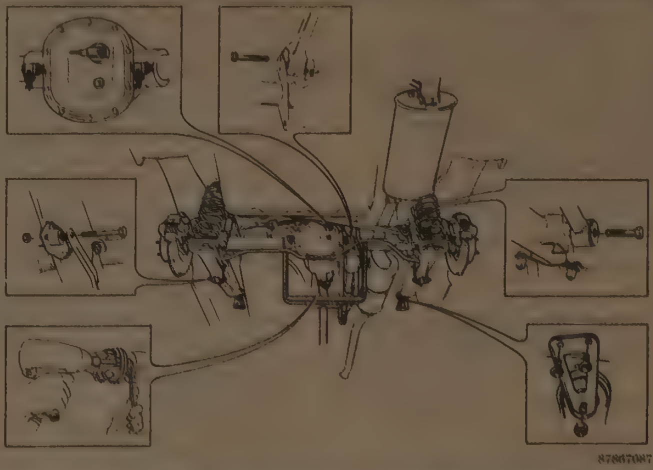


Fig. 105 Remove the axle by detaching the above components — 740 and 760 series models with Multi-link suspension

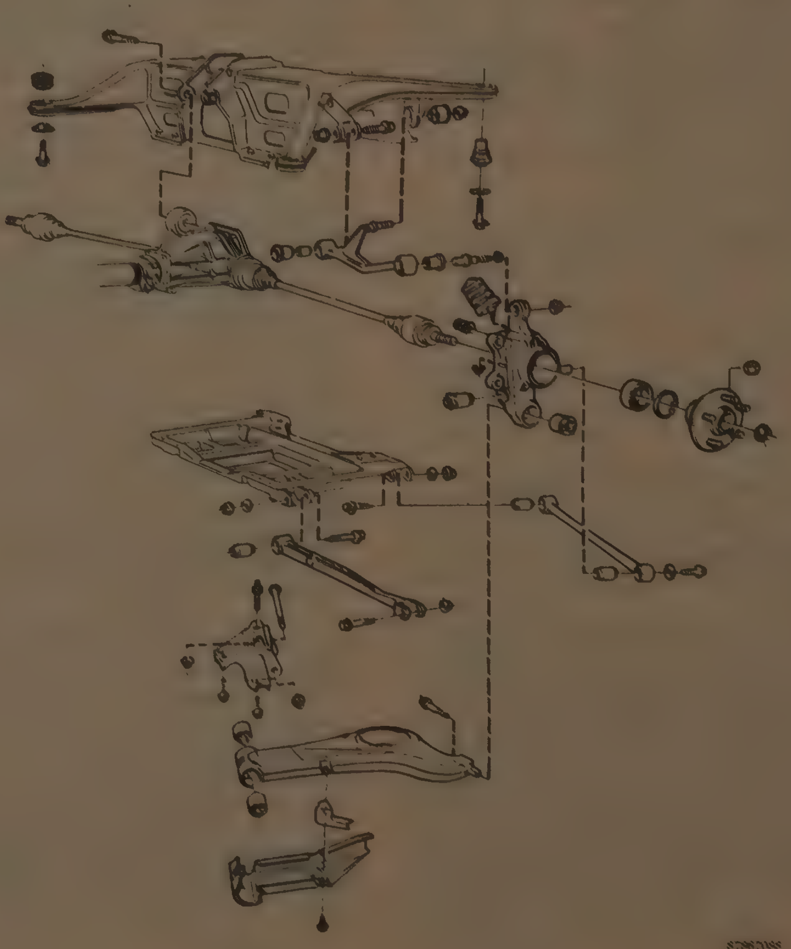


Fig. 106 Exploded view of the Multi-link final drive components

Troubleshooting the Manual Transmission

Problem	Cause	Solution
Transmission shifts hard	• Clutch adjustment incorrect	• Adjust clutch
	• Clutch linkage or cable binding	• Lubricate or repair as necessary
	• Shift rail binding	• Check for mispositioned selector arm roll pin, loose cover bolts, worn shift rail bores, worn shift rail, distorted oil seal, or extension housing not aligned with case. Repair as necessary.
	• Internal bind in transmission caused by shift forks, selector plates, or synchronizer assemblies	• Remove, dissemble and inspect transmission. Replace worn or damaged components as necessary.
	• Clutch housing misalignment	• Check runout at rear face of clutch housing
	• Incorrect lubricant	• Drain and refill transmission
	• Block rings and/or cone seats worn	• Blocking ring to gear clutch tooth face clearance must be 0.030 inch or greater. If clearance is correct it may still be necessary to inspect blocking rings and cone seats for excessive wear. Repair as necessary.
Gear clash when shifting from one gear to another	• Clutch adjustment incorrect	• Adjust clutch
	• Clutch linkage or cable binding	• Lubricate or repair as necessary
	• Clutch housing misalignment	• Check runout at rear of clutch housing
	• Lubricant level low or incorrect lubricant	• Drain and refill transmission and check for lubricant leaks if level was low. Repair as necessary.
	• Gearshift components, or synchronizer assemblies worn or damaged	• Remove, disassemble and inspect transmission. Replace worn or damaged components as necessary.
Transmission noisy	• Lubricant level low or incorrect lubricant	• Drain and refill transmission. If lubricant level was low, check for leaks and repair as necessary.
	• Clutch housing-to-engine, or transmission-to-clutch housing bolts loose	• Check and correct bolt torque as necessary
	• Dirt, chips, foreign material in transmission	• Drain, flush, and refill transmission
	• Gearshift mechanism, transmission gears, or bearing components worn or damaged	• Remove, disassemble and inspect transmission. Replace worn or damaged components as necessary.
	• Clutch housing misalignment	• Check runout at rear face of clutch housing
Jumps out of gear	• Clutch housing misalignment	• Check runout at rear face of clutch housing
	• Gearshift lever loose	• Check lever for worn fork. Tighten loose attaching bolts.
	• Offset lever nylon insert worn or lever attaching nut loose	• Remove gearshift lever and check for loose offset lever nut or worn insert. Repair or replace as necessary.
	• Gearshift mechanism, shift forks, selector plates, interlock plate, selector arm, shift rail, detent plugs, springs or shift cover worn or damaged	• Remove, disassemble and inspect transmission cover assembly. Replace worn or damaged components as necessary.
	• Clutch shaft or roller bearings worn or damaged	• Replace clutch shaft or roller bearings as necessary

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Troubleshooting Basic Automatic Transmission Problems

Problem	Cause	Solution
Fluid leakage	• Defective pan gasket • Loose filler tube • Loose extension housing to transmission case • Converter housing area leakage	• Replace gasket or tighten pan bolts • Tighten tube nut • Tighten bolts • Have transmission checked professionally
Fluid flows out the oil filler tube	• High fluid level • Breather vent clogged • Clogged oil filter or screen • Internal fluid leakage	• Check and correct fluid level • Open breather vent • Replace filter or clean screen (change fluid also) • Have transmission checked professionally
Transmission overheats (this is usually accompanied by a strong burned odor to the fluid)	• Low fluid level • Fluid cooler lines clogged • Heavy pulling or hauling with insufficient cooling • Faulty oil pump, internal slippage	• Check and correct fluid level • Drain and refill transmission. If this doesn't cure the problem, have cooler lines cleared or replaced. • Install a transmission oil cooler • Have transmission checked professionally
Buzzing or whining noise	• Low fluid level • Defective torque converter, scored gears	• Check and correct fluid level • Have transmission checked professionally
No forward or reverse gears or slippage in one or more gears	• Low fluid level • Defective vacuum or linkage controls, internal clutch or band failure	• Check and correct fluid level • Have unit checked professionally
Delayed or erratic shift	• Low fluid level • Broken vacuum lines • Internal malfunction	• Check and correct fluid level • Repair or replace lines • Have transmission checked professionally

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Transmission Fluid Indications

The appearance and odor of the transmission fluid can give valuable clues to the overall condition of the transmission. Always note the appearance of the fluid when you check the fluid level or change the fluid. Rub a small amount of fluid between your fingers to feel for grit and smell the fluid on the dipstick.

If the fluid appears:	**It indicates:**
Clear and red colored	• Normal operation
Discolored (extremely dark red or brownish) or smells burned	• Band or clutch pack failure, usually caused by an overheated transmission. Hauling very heavy loads with insufficient power or failure to change the fluid, often result in overheating. Do not confuse this appearance with newer fluids that have a darker red color and a strong odor (though not a burned odor).
Foamy or aerated (light in color and full of bubbles)	• The level is too high (gear train is churning oil) • An internal air leak (air is mixing with the fluid). Have the transmission checked professionally.
Solid residue in the fluid	• Defective bands, clutch pack or bearings. Bits of band material or metal abrasives are clinging to the dipstick. Have the transmission checked professionally.
Varnish coating on the dipstick	• The transmission fluid is overheating

87867C05

Lockup Torque Converter Service Diagnosis

Problem	Cause	Solution
No lockup	• Faulty oil pump	• Replace oil pump
	• Sticking governor valve	• Repair or replace as necessary
	• Valve body malfunction (a) Stuck switch valve (b) Stuck lockup valve (c) Stuck fail-safe valve	• Repair or replace valve body or its internal components as necessary
	• Failed locking clutch	• Replace torque converter
	• Leaking turbine hub seal	• Replace torque converter
	• Faulty input shaft or seal ring	• Repair or replace as necessary
Will not unlock	• Sticking governor valve	• Repair or replace as necessary
	• Valve body malfunction (a) Stuck switch valve (b) Stuck lockup valve (c) Stuck fail-safe valve	• Repair or replace valve body or its internal components as necessary
Stays locked up at too low a speed in direct	• Sticking governor valve	• Repair or replace as necessary
	• Valve body malfunction (a) Stuck switch valve (b) Stuck lockup valve (c) Stuck fail-safe valve	• Repair or replace valve body or its internal components as necessary
Locks up or drags in low or second	• Faulty oil pump	• Replace oil pump
	• Valve body malfunction (a) Stuck switch valve (b) Stuck fail-safe valve	• Repair or replace valve body or its internal components as necessary
Sluggish or stalls in reverse	• Faulty oil pump	• Replace oil pump as necessary
	• Plugged cooler, cooler lines or fittings	• Flush or replace cooler and flush lines and fittings
	• Valve body malfunction (a) Stuck switch valve (b) Faulty input shaft or seal ring	• Repair or replace valve body or its internal components as necessary
Loud chatter during lockup engagement (cold)	• Faulty torque converter	• Replace torque converter
	• Failed locking clutch	• Replace torque converter
	• Leaking turbine hub seal	• Replace torque converter
Vibration or shudder during lockup engagement	• Faulty oil pump	• Repair or replace oil pump as necessary
	• Valve body malfunction	• Repair or replace valve body or its internal components as necessary
	• Faulty torque converter	• Replace torque converter
	• Engine needs tune-up	• Tune engine
Vibration after lockup engagement	• Faulty torque converter	• Replace torque converter
	• Exhaust system strikes underbody	• Align exhaust system
	• Engine needs tune-up	• Tune engine
	• Throttle linkage misadjusted	• Adjust throttle linkage
Vibration when revved in neutral	• Torque converter out of balance	• Replace torque converter
Overheating: oil blows out of dip stick tube or pump seal	• Plugged cooler, cooler lines or fittings	• Flush or replace cooler and flush lines and fittings
	• Stuck switch valve	• Repair switch valve in valve body or replace valve body
Shudder after lockup engagement	• Faulty oil pump	• Replace oil pump
	• Plugged cooler, cooler lines or fittings	• Flush or replace cooler and flush lines and fittings
	• Valve body malfunction	• Repair or replace valve body or its internal components as necessary
	• Faulty torque converter	• Replace torque converter
	• Fail locking clutch	• Replace torque converter
	• Exhaust system strikes underbody	• Align exhaust system
	• Engine needs tune-up	• Tune engine
	• Throttle linkage misadjusted	• Adjust throttle linkage

87867C06

BASIC DRIVESHAFT PROBLEMS

Problem	Cause	Solution
Shudder as car accelerates from stop or low speed	• Loose U-joint • Defective center bearing	• Replace U-joint • Replace center bearing
Loud clunk in driveshaft when shifting gears	• Worn U-joints	• Replace U-joints
Roughness or vibration at any speed	• Out-of-balance, bent or dented driveshaft • Worn U-joints • U-joint clamp bolts loose	• Balance or replace driveshaft • Replace U-joints • Tighten U-joint clamp bolts
Squeaking noise at low speeds	• Lack of U-joint lubrication	• Lubricate U-joint; if problem persists, replace U-joint
Knock or clicking noise	• U-joint or driveshaft hitting frame tunnel • Worn CV joint	• Correct overloaded condition • Replace CV joint

87867C07

NOISE DIAGNOSIS

The Noise Is	Most Probably Produced By
• Identical under Drive or Coast	• Road surface, tires or front wheel bearings
• Different depending on road surface	• Road surface or tires
• Lower as the car speed is lowered	• Tires
• Similar with car standing or moving	• Engine or transmission
• A vibration	• Unbalanced tires, rear wheel bearing, unbalanced driveshaft or worn U-joint
• A knock or click about every 2 tire revolutions	• Rear wheel bearing
• Most pronounced on turns	• Damaged differential gears
• A steady low-pitched whirring or scraping, starting at low speeds	• Damaged or worn pinion bearing
• A chattering vibration on turns	• Wrong differential lubricant or worn clutch plates (limited slip rear axle)
• Noticed only in Drive, Coast or Float conditions	• Worn ring gear and/or pinion gear

87867C08

8

SUSPENSION AND STEERING

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FRONT SUSPENSION

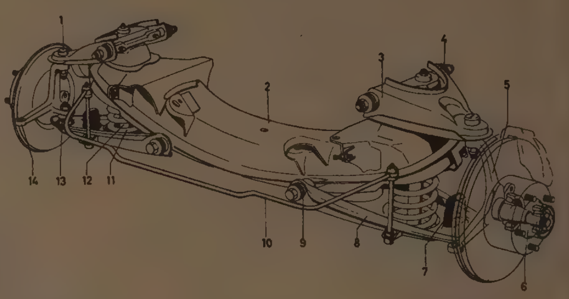
See Figures 1 and 2

All 140 series, 164, and 1800 series model Volvos use a coil spring, independent front suspension incorporating upper and lower control arms bolted to each side of the rigid front frame member. The coil springs and telescopic double-acting shock absorbers are bolted to the lower control arms at the bottom and seat in the crossmember at the top. A pair of steering knuckles are carried in ball joints between the upper and lower control arms. A stabilizer bar is attached to the lower control arm and to the body.

All 200 series and later model Volvos use a coil spring independent front suspension with a pair of MacPherson type struts located between a sheet metal tower at the top and the lower control arm at the bottom.

The MacPherson strut design incorporates the coil spring, shock absorber and wheel spindle into a single assembly, eliminating the need for an upper control arm. The MacPherson strut design provides for generous vertical suspension travel allowing the use of softer springs. The strut design is, however, extremely sensitive to front wheel imbalance and the slightest imbalance often leads to front end wobble.

On the earlier cars with front struts, the caster angle of the front suspension is fixed and cannot be adjusted. (The angle is determined by the placement of the components; if the caster is found to be out of specification during an alignment, bent components must be identified and replaced.) Later cars including the 700 Series have slotted upper mounts which allow a small range of caster adjustment.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14
1. Upper ball joint
2. Front cross member
3. Upper control arm
4. Upper control arm bushing
5. Steering knuckle
6. Hub
7. Rubber buffer
8. Lower control arm
9. Lower control arm bushing
10. Stabilizer
11. Coil spring
12. Shock absorber
13. Lower ball joint
14. Steering arm
87868002

Fig. 2 Details of the front suspension assembly — 140 series and 164 (shown) — the 1800 models are similar

Coil Spring

REMOVAL & INSTALLATION

140 Series and 164 Models

1. Remove the hub cap and loosen the lug nuts two or three turns.
2. Firmly apply the parking brake and place blocks in back of the rear wheels. Jack up the front of the car and place jackstands in back of the front jacking points. Remove the front wheels.
3. Remove the shock absorber.
4. Remove the cotter pin and ball nut; disconnect the steering rod from the steering knuckle. Loosen the clamp for the

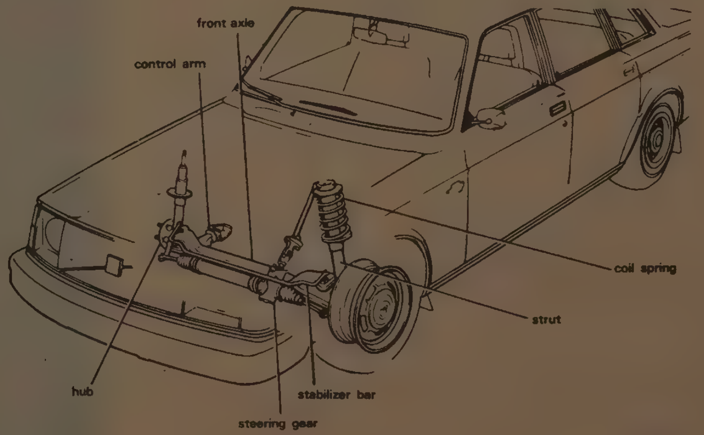

front axle
control arm
coil spring
strut
hub
stabilizer bar
steering gear
87868001

Fig. 1 Cutaway view of the MacPherson strut suspension — 200 and 700 series

flexible brake hoses. Remove the stabilizer attachment from the lower control arm.

5. Place a jack under the lower control arm. Raise the jack to unload the lower control arm. Remove the cotter pins and loosen the nuts for the upper and lower ball joints; then rap with a hammer until they loosen from the spindle. Remove the nuts and lower the jack slightly.

6. Remove the steering knuckle with the front brake caliper and disc still connected to the brake lines. In order not to stretch the brake lines, place the brake unit on a milk crate or other suitable stand.

✻✻CAUTION

Do not attempt to remove the spring until it is fully extended. As an added safety measure, a chain may be attached to the lower spring coil and secured to the frame.

7. Slowly lower the jack and the lower control arm to the fullest extent. Remove the spring and rubber spacer.

To install:

8. Place a jack directly beneath the spring attachment point on the lower control arm. Place the spring with the rubber spacer in position, and lift up the lower control arm with the jack so that the steering knuckle and brake unit assembly may be installed.

9. Install and tighten the upper and lower ball joint nuts. Connect the stabilizer to its attachment on the lower control arm.

10. Install the shock absorber.

11. With the wheel pointing straight ahead, and the lower control arm unloaded, connect the steering rod to the steering knuckle and install the ball nut and cotter pin.

12. Clamp the brake hoses to the stabilizer bolt.

13. Install the wheel. Remove the jackstands and lower the car. Tighten the lug nuts to 85-90 ft. lbs. (115-122 Nm) and install the hub cap.

1800 Series

1. Remove the hub cap and loosen the lug nuts a turn or two.

2. Firmly apply the parking brake and place blocks in back of the rear wheels.

3. Jack up the front of the car and place jackstands beneath the front crossmember. Remove the wheel.

4. Remove the shock absorber.

5. Position a jack directly beneath the lower spring attachment on the lower control arm, and raise the jack until the upper control arm rubber buffer is lifted.

6. Disconnect the stabilizer from the lower control arm. Remove the cotter pin and ball nut from the lower ball joint.

✻✻CAUTION

Do not attempt to remove the spring until it is fully extended. As an added safety measure, a chain may be attached to the lower spring coil and secured to the frame.

7. Slowly lower the jack and the lower control arm. If the lower ball joint does not release when the jack is lowered, it must be pressed out with a press tool (Volvo No. 2281 or similar). When the lower control arm is lowered sufficiently, carefully remove the spring, rubber spacer and washer assembly.

To install:

8. When reinstalling, take care to place the rubber spacer and washer correctly on top of the spring, prior to installation. Position the jack under the lower arm and place the spring in its seat.

9. Slowly raise the jack and lower arm. As the spring comes into position, make sure it seats properly at the top and reconnect and tighten the lower ball joint. Install a new cotter pin when the nut is secure.

10. Reconnect the stabilizer to the lower control arm.

11. Install the shock absorber.

12. Install the wheel. Lower the car from its stands and tighten the wheel lugs to 75 ft. lbs. (102 Nm).

200 and 700 Series With MacPherson Struts

➧ See Figures 3 and 4

✻✻CAUTION

Use of the correct special tools or their equivalent is REQUIRED for this procedure. To remove the spring, a coil spring compressor must be used. Under no circumstances should you attempt to lower and disassemble the strut assembly without the proper spring compressor. Serious injury could result. Spring compressors can be rented from many repair and supply shops.

1. Remove the hub cap and loosen the lug nuts two or three turns.

2. Firmly apply the parking brake and place blocks in back of the rear wheels.

3. Install the spring compressor on the spring directly beneath the upper mount. Make sure that at least 3 coils of the spring are between the tool attachment points. Tighten the tool and compress the spring.

4. Jack up the front of the car at the center of the front crossmember. When the wheels are 2-3 in. (50-75mm) off the ground, the car is high enough. Place jackstands beneath the front jacking points. Remove the floor jack from the crossmember, and reposition it beneath the lower control arm to provide support at the outer end. Remove the wheel.

5. Using a ball joint puller, disconnect the steering rod from the steering arm.

6. Disconnect the stabilizer bar at the upper link.

7. Remove the bolt holding the brake line bracket to the fender well.

8. Open the hood and remove the cover from the top of the strut assembly upper mount. Mark the position of the upper mounts relative to their holes.

9. While keeping the strut from turning, loosen and remove the nut for the upper strut mount.

10. Before lowering the strut assembly, wire or tie the strut to some stationary component (or use a holding fixture such as Volvo No. 5045) to prevent the strut from traveling down too far and damaging the hydraulic brake lines. Lower the jack supporting the lower arm and allow the strut to tilt out at about a 60° angle. At this angle, the top of the strut assembly should just protrude past the wheel well, allowing removal of the strut components from the top. Take great care to control the descent of the strut and prevent damage to the fender.

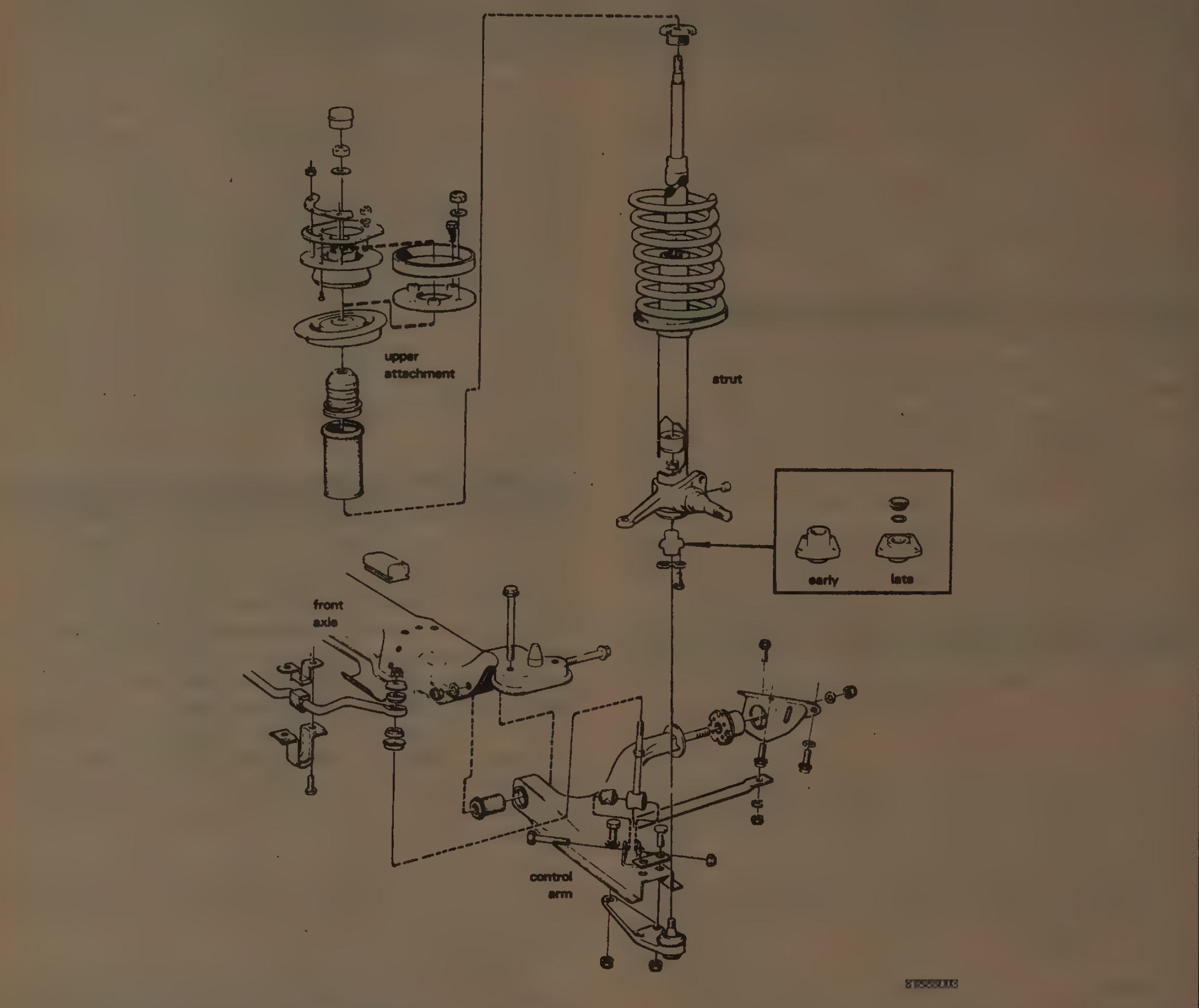


Fig. 3 Exploded view of the front suspension — 200 series

11. Lift off the spring seat, rubber bumper, and the shock absorber protector. On 700 series, the upper spring mount must be removed from the shaft. Remove the coil spring and compressor assembly from the strut.

12. Slowly relieve the tension on the compressor and remove it from the spring. Place the compressor on the replacement spring (making sure at least 3 coils separate the attachment points as before) and compress.

➡If the spring compressor does not have enough travel to fully release the spring tension, it will be necessary to use another sandwich type compressor to remove the original compressor once the spring is out of the car.

To install:

13. Position the new spring and compressor on the strut assembly. On 700 Series, install the upper spring mount. Make sure the spring end is properly aligned with the lower mount.

➡Make sure that the compressor bolts face downwards.

14. Install the rubber bumper and the shock absorber protector. Position the spring seat on the spring, making sure it is aligned with the spring.

15. Carefully lift and guide the strut assembly into its upper attachment in the spring tower. Connect the stabilizer bar to the stabilizer link.

16. Guide the shock absorber spindle into the upper attachment and raise the jack beneath the lower control arm. Install the washer and nut on top of the shock absorber spindle. Position the upper mount according to marks made during removal. Tighten the upper mounting bolts. The smaller outer nuts should be tightened to 15-25 ft. lbs. (20-34 Nm). The large center nut should be tightened to 90-100 ft. lbs. (122-135 Nm).

17. Install the cover.

18. Attach the brake line bracket to its mount. Make sure that the brake lines sit properly in their mounts. Tighten the nut holding the stabilizer bar to the link. Connect the steering rod at the steering arm.

19. Release the coil spring compressor and install the wheel and tire assembly. Remove the jackstands and lower the car.

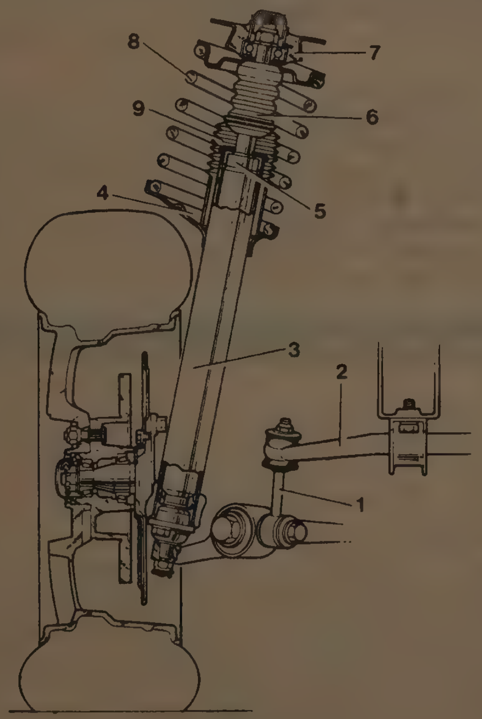
20. Push on the bumper to bounce the suspension a few times to settle the components.
21. Road test the vehicle.

Shock Absorbers

➡Shock absorbers are also commonly referred to as "dampers," for the function they perform of dampening the oscillations created by the moving vehicle over uneven road surfaces.

The purpose of the shock absorbers is simply to limit the motion of the spring during compression (bump) and rebound cycles. If the car were not equipped with these motion dampers, the up and down motion of the car would multiply until the vehicle was alternately trying to leap off the ground and to pound itself into the pavement.

Contrary to popular opinion, the shocks do not affect the ride height of the car nor do they affect the ride quality except for limiting the pitch or bounce of the car. These factors are controlled by other suspension components such as springs and tires. The simplest test of the shock absorbers is simply to push down on one corner of the unladen car and release it.



1. Anti-roll bar (sway bar) link
2. Anti-roll bar (sway bar)
3. Spring strut tube
4. Spring lower seat
5. Shock absorber
6. Rubber bumper
7. Upper mount
8. Coil spring
9. Rubber bellows

Fig. 4 Cutaway view of the front suspension — 700 series

Observe the motion of the body as it is released. In most cases, it will come up beyond its original rest position, dip back below it and settle quickly to rest. This shows that the damper is slowing and controlling the spring action. Any tendency to excessive pitch (up-and-down) motion or failure to return to rest within 2-3 cycles is a sign of poor function within the shock absorber.

While it is true that each shock absorber can be replaced individually, it is highly recommended that they be changed as a pair (both front or both rear) to maintain equal response on both sides of the car. Chances are quite good that if one has failed, its mate is weak also.

REMOVAL & INSTALLATION

140 Series and 164 Models

1. Raise and safely support the vehicle with jackstands.
2. Remove the upper nut, washer, and outer rubber bushing.
3. Remove the two lower attaching bolts beneath the lower control arm, and pull the shock absorber assembly down and out.
4. Test the damping action of the shock absorber. Secure the bottom of the shock in a vise and extend and compress the shaft. Definite resistance should be felt in each direction, although the amount of effort required in each direction may be greatly different. If the shock absorber is operating properly and is being reinstalled, be sure to use new rubber bushings on top.
5. Position the inner washer, spacing sleeve, and inner rubber bushing on top of the shock absorber.
6. Position the shock to its upper and lower attachments, and install the lower attaching bolts.
7. Install the outer rubber bushing, washer, and the upper nut on top of the unit. Tighten the upper nut until it makes firm contact with the spacing sleeve.

1800 Series

1. Raise and safely support the vehicle with jackstands.
2. Remove the upper nut, washer, and outer rubber bushing from the top of the shock absorber.
3. Remove the lower nut, washer, and outer rubber bushing from beneath the shock absorber.
4. Remove the two lower attaching bolts from beneath the lower control arm, and pull the shock absorber assembly down and out.
5. Test the damping action of the shock absorber. Secure the bottom of the shock in a vise and extend and compress the shaft. Definite resistance should be felt in each direction, although the amount of effort required in each direction may be greatly different. If the shock absorber is operating properly and is being reinstalled, be sure to use new rubber bushings on top.
6. Place the shock absorber through the lower control arm and install the two lower bolts.
7. Install the lower nut, washer and bushing.
8. Install the upper bushing, washer and nut.

200 and 700 Series With MacPherson Struts

CAUTION

Use of the correct special tools or their equivalent is REQUIRED for this procedure. To remove the spring, a coil spring compressor must be used. Under no circumstances should you attempt to lower and disassemble the strut assembly without the proper spring compressor. Serious injury could result. Spring compressors can be rented from many repair and supply shops.

1. Remove the hub cap and loosen the lug nuts two or three turns.
2. Firmly apply the parking brake and place blocks in back of the rear wheels.
3. Install the spring compressor on the spring directly beneath the upper mount. Make sure that at least 3 coils of the spring are between the tool attachment points. Tighten the tool and compress the spring.
4. Jack up the front of the car at the center of the front crossmember. When the wheels are 2-3 in. (50-75mm) off the ground, the car is high enough. Place jackstands beneath the front jacking points. Remove the floor jack from the crossmember, and reposition it beneath the lower control arm to provide support at the outer end. Remove the wheel.
5. Using a ball joint puller, disconnect the steering rod from the steering arm.
6. Disconnect the stabilizer bar at the upper link.
7. Remove the bolt holding the brake line bracket to the fender well.
8. Open the hood and remove the cover from the top of the strut assembly upper mount. Mark the position of the upper mounts relative to their holes.
9. While keeping the strut from turning, loosen and remove the nut for the upper strut mount.
10. Before lowering the strut assembly, wire or tie the strut to some stationary component (or use a holding fixture such as Volvo No. 5045) to prevent the strut from traveling down too far and damaging the hydraulic brake lines. Lower the jack supporting the lower arm and allow the strut to tilt out at about a 60° angle. At this angle, the top of the strut assembly should just protrude past the wheel well, allowing removal of the strut components from the top. Take great care to control the descent of the strut and prevent damage to the fender.
11. Lift off the spring seat, rubber bumper, and the shock absorber protector. On 700 series, the upper spring mount must be removed from the shaft. Remove the coil spring and compressor assembly from the strut.
12. While keeping the strut outer tube from turning, remove the upper shock absorber retaining nut.

➡The shock absorber unit is a sealed unit. It cannot be repaired or overhauled.

13. Pull the shock absorber unit out of the outer tube (casing).

➡On some models, gas type shock absorbers are used. A special tool (such as Volvo No. 5173 or similar) must be used to remove and install the unit.

14. Install the new shock absorber unit into the outer tube and install the retaining nut. You can stop the outer tube from turning with the nut by holding the tube at the weld with a pair of locking pliers.
15. Pull the shock absorber shaft to its uppermost position.
16. Position the spring and compressor on the strut assembly. On 700 series, install the upper spring mount. Make sure the spring end is properly aligned with the lower mount.

➡Make sure that the compressor bolts face as they did during removal.

17. Install the rubber bumper and the shock absorber protector. Position the spring seat on the spring, making sure it is aligned with the spring.
18. Carefully lift and guide the strut assembly into its upper attachment in the spring tower. Connect the stabilizer bar to the stabilizer link.
19. Guide the shock absorber spindle into the upper attachment and raise the jack beneath the lower control arm. Install the washer and nut on top of the shock absorber spindle. Position the upper mount according to marks made during removal. Tighten the upper mounting bolts. The smaller outer nuts should be tightened to 15-25 ft. lbs. (20-34 Nm). The large center nut should be tightened to 90-100 ft. lbs. (122-135 Nm).
20. Install the cover.
21. Attach the brake line bracket to its mount. Make sure that the brake lines sit properly in their mounts. Tighten the nut holding the stabilizer bar to the link. Connect the steering rod at the steering arm.
22. Release the coil spring compressor and install the wheel and tire assembly. Remove the jackstands and lower the car. Bounce the suspension a few times and then road test.

Upper Ball Joint

INSPECTION

140 Series, 164 Models and 1800 Series

➧ See Figure 5

If the upper ball joint is worn, the wheel and tire assembly will exhibit excessive play when the joint is unloaded. Place a jack beneath the lower control arm and lift the wheel until clear of the ground. Make sure that the upper control arm is not making contact with the rubber stop.

Firmly grasp the top and bottom of the tire and try to rock it in and out; that is, intermittently push the top of the tire towards the engine compartment, then pull it away from the car, while simultaneously doing the opposite to the bottom of the tire. Replace the upper ball joint if the radial play of the wheel and tire assembly is excessive.

➡Do not confuse possible wheel bearing play with ball joint play. It is advisable that the wheel bearing adjustment procedure in Section 9 be followed prior to replacing the ball joint.

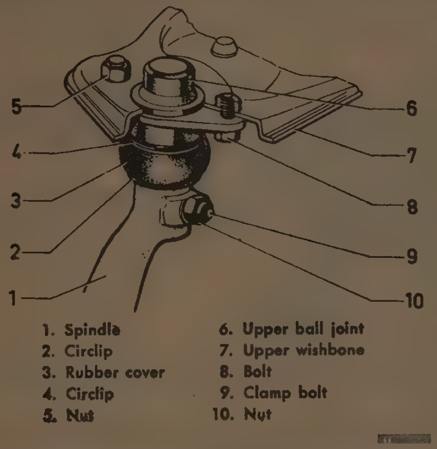


Fig. 5 Details of the upper ball joint — 1800 series

REMOVAL & INSTALLATION

140 and 160 Series

1. Remove the hub cap and loosen the lug nuts two or three turns.
2. Jack up the front of the vehicle and place jackstands beneath the front jacking points. Remove the wheel.
3. Loosen, but do not remove the nut for the upper ball joint. With a hammer, tap around the ball joint stud on the steering knuckle until it loosens. Remove the nut, and safety wire the upper end of the steering knuckle to the stabilizer bar to avoid straining the flexible brake hoses.
4. Loosen the nut for the upper control arm shaft ½ turn. Lift up the control arm slightly and press out the old ball joint with a press tool and a sleeve.

To install:

5. Make sure that the rubber cover of the new ball joint is filled with multipurpose grease. Bend the pin end over the slot, and make sure that the grease forces its way out.
6. Press the ball joint into the upper control arm using the press tool, a sleeve, and a drift. It is imperative that the ball joint be aligned so that the slot comes into line with the longitudinal shaft of the control arm (either internally or externally) as the pin has maximum movement along this line.
7. Lower the upper control arm to its operating position, and tighten the shaft nuts to 40-45 ft. lbs. (54-61 Nm). Remove the safety wire and place the steering knuckle in position. Install and tighten the ball nut to 60-70 ft. lbs. (81-95 Nm). If the pin rotates during tightening, clamp it firmly with a screw vise.
8. Install the wheel. Remove the jackstands and lower the vehicle. Tighten the lug nuts to 85-90 ft. lbs. (115-122 Nm), then install the hub cap.

1800 Series

1. Remove the hub cap and loosen the lug nuts two or three turns.
2. Jack up the front of the vehicle and place jackstands beneath the lower control arms. Remove the wheel.
3. Remove the two nuts and bolts which hold the ball joint to the upper control arm. Lift the upper control arm up and out of the way.
4. Remove the clamping nut and bolt which secure the ball joint to the steering knuckle. Remove the upper ball joint, sealing washers, and rubber cover assembly.

To install:

5. Make sure that the rubber cover of the new ball joint is filled with multipurpose grease. If the old ball joint is being reused, make sure that the rubber cover is not damaged, and fill it with grease.
6. After making sure that the sleeve and sealing washers (circlips) are positioned properly, place the ball joint assembly on the steering knuckle and install the clamping nut and bolt.
7. Lower the upper control arm into position over the ball joint and install the attaching nuts and bolts.
8. Install the wheel. Remove the jackstands and lower the vehicle. Tighten the lug nuts to 85-90 ft. lbs. (115-122 Nm), then install the hub cap.

Lower Ball Joint

INSPECTION

140 Series, 164 Models and 1800 Series

➧ See Figures 6 and 7

If the lower ball joint is worn, measurement (A) taken from the ball stud to the cover of the ball joint will exceed to the maximum allowable length. The check is made with the vehicle standing on the ground, wheels pointing straight ahead.

Two types of lower ball joints have been used on late model Volvos; only one uses a pressure spring inside. The maximum allowable length of the spring type ball joint is 4.5 in. (114mm) for the 140 series and 164, and 4.4 in. (112mm) for the 1800 series. The maximum allowable length for the non-spring type ball joint is 3.91 in. (99mm) for the 140 series and 164 model, and 3.76 in. (96mm) for the 1800 series.

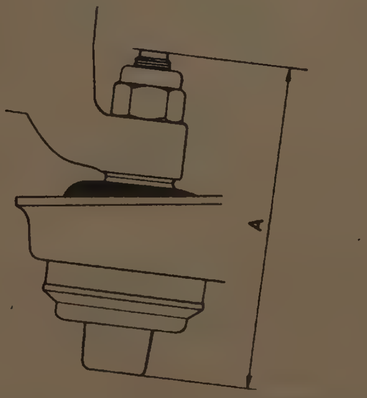


Fig. 6 Measure the spring type lower ball joint's maximum allowable length within the confines of dimension "A"

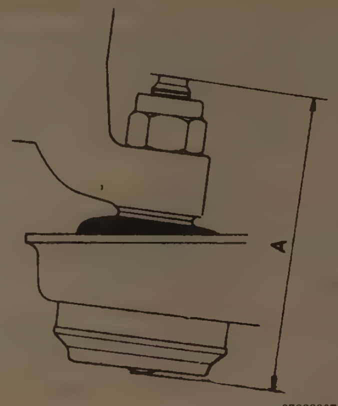


Fig. 7 Measure the non-spring type lower ball joint's maximum allowable length within the confines of dimension "A"

240 and 260 Series (1980 and Later Models)

To check the lower ball joints, place a jack under the lower control arm as close to the wheel as possible. Raise the jack just enough to bring the tire clear of the ground and check ball joint play with the loaded weight of the car on the jack. Check the play with a tire iron or some suitable pry bar but be careful not to damage the rubber dust cover. Maximum allowable play is 0.118 in. (3mm).

REMOVAL & INSTALLATION

140 and 160 Series

1. Remove the hub cap and loosen the lug nuts two or three turns.
2. Jack up the front of the vehicle and place jackstands beneath the front jacking points. Remove the wheel.
3. Remove the brake lines from their bracket at the stabilizer bolt. Remove the cotter pin and stud nut, and press the steering rod ball stud from the steering knuckle.
4. Remove the cotter pins and loosen but do not remove the nuts for both the upper and lower ball joints. Tap with a hammer until the ball joints loosen from the spindle. Place a jack beneath the lower control arm and raise it to unload the control arm. Remove the ball joint nuts.
5. Remove the steering knuckle with the front brakes still connected to the brake lines. In order not to stretch the brake lines, place the brake unit on a milk crate or other stand.
6. Press the lower ball joint out of the lower control arm with a press tool and sleeve.
7. Make sure that the rubber cover of the new ball joint is filled with multipurpose grease. Bend the pin end to the side, and make sure that the grease forces its way out.

To install:

8. Press the lower ball joint into its control arm with a press tool, sleeve and drift. Make sure that the ball joint is not loose in the control arm.
9. Position the steering knuckle and brake unit assembly between the upper and lower control arms and tighten the ball joint stud nuts to the upper ball joint to 60-70 ft. lbs. (81-95 Nm), and for the lower ball joint to 75-90 ft. lbs. (102-122 Nm). If the pins rotate during tightening, clamp them firmly with a screw vise.
10. Install the steering rod ball stud into the steering knuckle and tighten the stud nut. Lower the jack slightly and, with the front wheels pointing straight ahead, attach the brake lines to their bracket at the stabilizer bolt.
11. Install the wheel. Remove the jackstands and lower the vehicle. Tighten the lug nuts to 85-90 ft. lbs. (115-122 Nm), then install the hub cap.

1800 Series

➧ **See Figures 8 and 9**

1. Remove the hub cap and loosen the lug nuts two or three turns.
2. Jack up the front of the car and place jackstands under the lower control arms. Remove the wheel.
3. Remove the four nuts (6) and bolts (8) which retain the ball joint to the lower control arm. Remove the cotter pin and ball stud nut which secure the steering knuckle to the ball joint.
4. Disconnect and plug the brake hoses at their retainer. Remove the ball joint from the steering knuckle by lightly tapping its attachment with a hammer.
5. Make sure that the rubber cover of the new ball joint is filled with multipurpose grease.

To install:

6. Place the ball joint, sealing washers (circlip), and sleeve into position on the steering knuckle and install the ball stud nut. Tighten the nut to 35-40 ft. lbs. (48-54 Nm).
7. Place the ball joint and steering knuckle assembly into position on the lower control arm and install the four retaining nuts and bolts.
8. Unplug and connect the brake hoses. Bleed the brake system.
9. Install the wheel and tire assembly. Remove the jackstands and lower the vehicle. Tighten the lug nuts to 85-90 ft. lbs. (115-122 Nm), then install the hub cap.

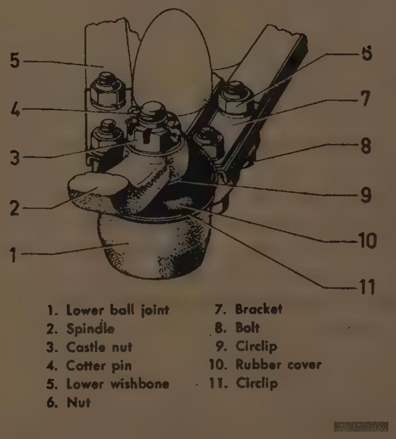


Fig. 8 Detailed view of the lower ball joint — 1800 series

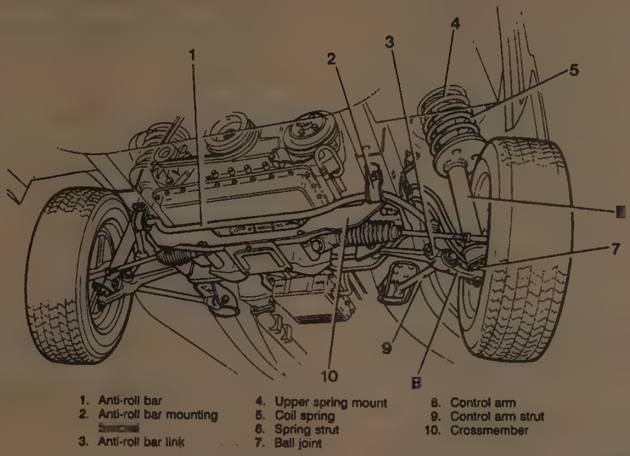


Fig. 9 Detailed view of the front suspension — 1800 series

1975-85 240 and 260 Series

CAUTION

The use of the correct special tools or their equivalent is REQUIRED for this procedure. To remove the spring, a coil spring compressor must be used. Under no circumstances should you attempt to lower and disassemble the strut assembly without the proper spring compressor. Serious injury could result. Spring compressors can be rented from many repair and supply shops.

1. Remove the hub cap and loosen the lug nuts two or three turns.
2. Firmly apply the parking brake and place blocks in back of the rear wheels.
3. Install the spring compressor on the spring directly beneath the upper mount. Make sure that at least 3 coils of the spring are between the tool attachment points. Tighten the tool and compress the spring.
4. Jack up the front of the car at the center of the front crossmember. When the wheels are 2-3 in. (50-75mm) off the ground, the car is high enough. Place jackstands beneath the front jacking points. Remove the floor jack from the crossmember, and reposition it beneath the lower control arm to provide support at the outer end. Remove the wheel.
5. Using a ball joint puller, disconnect the steering rod from the steering arm.
6. Disconnect the stabilizer bar at the upper link.
7. Remove the bolt holding the brake line bracket to the fender well.
8. Open the hood and remove the cover from the top of the strut assembly upper mount. Mark the position of the upper mounts relative to their holes.
9. While keeping the strut from turning, loosen and remove the nut for the upper strut mount.
10. Before lowering the strut assembly, wire or tie the strut to some stationary component (or use a holding fixture such as Volvo No. 5045) to prevent the strut from traveling down too far and damaging the hydraulic brake lines. Lower the jack supporting the lower arm and allow the strut to tilt out at about a 60° angle. At this angle, the top of the strut assembly should just protrude past the wheel well, allowing removal of the strut components from the top. Take great care to control the descent of the strut and prevent damage to the fender.
11. Lift off the spring seat, rubber bumper, and the shock absorber protector. Remove the coil spring and compressor assembly from the strut.
12. While keeping the strut outer tube from turning, remove the upper shock absorber retaining nut.
13. Pull the shock absorber unit out of the outer tube (casing).

➡On some models, gas type shock absorbers are used. A special tool (such as Volvo No. 5173 or similar) must be used to remove and install the unit.

14. Loosen the ball joint retaining nut, located inside the shock absorber tube. Grasp the outer tube at the weld (with a pair of locking pliers or a pipe wrench) and loosen the nut with a 19mm socket and a long extension, until the joint bracket comes loose.
15. Using a drift and hammer, loosen the cone-shaped part of the ball joint from the strut assembly.
16. Coat the inside of the 19mm socket with petroleum jelly or bearing grease. (The grease will keep the nut within the socket after loosening.) Remove the ball joint retaining nut.
17. Wire the top of the strut assembly to the tower, and allow the strut to hang vertically. Disconnect the ball joint from the bottom of the strut assembly. Take care not to damage the brake hoses. Then disconnect the ball joint from the lower control arm.

To install:

18. Attach the new ball joint to the lower control arm.

➡Make sure the new ball joint stud is free of grease, or the stud could be tightened too far into the cone making the rubber bellows stick to the strut.

19. Remove the wire and lift the strut assembly into position. Install the ball joint nut, and tighten to 30-50 ft. lbs. (41-68 Nm). Stop the outer tube from turning by holding it at the weld.

20. Install the shock absorber and retaining nut. Tighten to 30-50 ft. lbs. (41-68 Nm). Pull the shock absorber shaft to its uppermost position.
21. Position the spring and compressor on the strut assembly. Make sure the spring end is properly aligned with the lower mount.

➡Make sure that the compressor bolts face as they did during removal.

22. Install the rubber bumper and the shock absorber protector. Position the spring seat on the spring, making sure it is aligned with the spring.
23. Carefully lift and guide the strut assembly into its upper attachment in the spring tower. Connect the stabilizer bar to the stabilizer link.
24. Guide the shock absorber spindle into the upper attachment and raise the jack beneath the lower control arm. Install the washer and nut on top of the shock absorber spindle. Position the upper mount according to marks made during removal. Tighten the upper mounting bolts. The smaller outer nuts should be tightened to 15-25 ft. lbs. (20-34 Nm). The large center nut should be tightened to 90-100 ft. lbs. (115-122 Nm).
25. Install the cover.
26. Attach the brake line bracket to its mount. Make sure that the brake lines sit properly in their mounts. Tighten the nut holding the stabilizer bar to the link. Connect the steering rod at the steering arm.
27. Release the coil spring compressor and install the wheel and tire assembly. Remove the jackstands and lower the car. Bounce the suspension a few times and then road test.

240 and 260 Series (1986 and Later Models)

1. Jack up the front of the car and install jackstands beneath the front jacking attachments.
2. Remove the wheel.
3. Reach in between the spring coils and loosen the lower shock absorber retaining nut two or three turns. On cars built after 1978, this is NOT necessary as the shock absorber does not rest against the ball joint mount.
4. Remove the four bolts (12mm) retaining the ball joint seat to the bottom of the strut.
5. Remove the three nuts (19mm) retaining the ball joint to the lower control arm.
6. Place the ball joint and attachment assembly in a vise and remove the 19mm nut from the ball joint stud. Then drive out the old ball joint.

To install:

7. Install the new ball joint in the attachment and tighten the stud nut to 35-50 ft. lbs. (47-68 Nm).

➡On 1979 and later models with power steering, the ball joints are different for the left and right side. Compared to previous years, the ball joint is 0.393 in. (10mm) forward in the control rod attachment. It is therefore most important that these ball joints are installed on the correct side.

8. Attach the ball joint assembly to the strut. Always use new locking bolts or washers. Tighten to 15-20 ft. lbs. (20-27 Nm).
9. Attach the ball joint assembly to the control arm. Tighten to 70-95 ft. lbs. (95-129 Nm).
10. Tighten the shock absorber retaining nut if it had been loosened. Install the wheel. Lower the car and road test.

700 Series

1. Jack up the front end of the car, support on stands and remove the wheel.
2. Remove the bolt connecting the anti-roll bar (sway bar) link to the control arm.
3. Remove the cotter pin for the ball joint stud, and remove the nut.
4. Using a ball joint puller, press out the ball joint from the control arm. Make sure the puller is located directly in line with the stud, and that the rubber grease boot is not damaged by the puller.
5. Remove the bolts holding the ball joint to the spring strut. Press the control arm down and remove the ball joint.

To install:

6. Always use new bolts and coat all threads with a liquid thread sealer. Torque bolts to 22 ft. lb. (30 Nm), checking that the bolt heads sit flat on the ball joint, then tighten an additional 90° of rotation.
7. Install the nut holding the control arm ball joint stud and tighten to 44 ft. lbs. (60 Nm). Always use a new cotter pin on the ball joint stud.
8. Install the anti-roll bar link.
9. Install the wheel and lower the car to the ground.

Sway Bar

The sway bar, variously called the anti-roll bar or stabilizer bar, serves to control the sideways roll of the body during cornering. While the bar itself rarely fails, the links and bushings around it are prone to wear. If the bar is not rigidly mounted to the car, it cannot do its job properly.

Sway bars of different diameters (thicknesses) can stiffen or soften the roll characteristics of a vehicle. Bushings are easily replaced and well worth the effort in terms of restoring proper cornering manners to your car.

REMOVAL & INSTALLATION

All Models

1. Loosen the front wheel nuts two or three turns. Elevate the front end and position jackstands under the front control arms. On the 700 series, position the jackstands underneath the jacking attachments.
2. Lower the car onto the stands and make sure the stands are properly supporting the control arms.
3. Remove the wheels. Remove the underside splashguard panel if so equipped.
4. Loosen and remove the upper nut holding the sway bar to the link.
5. Remove the upper link nut on the opposite side. The bar now hangs by its two forward brackets.
6. Remove the bolts for the two retaining brackets and remove the bar.
7. If the link bushings are worn, remove the lower link bolts and remove the entire link. Inspect all the bushings for compression or elongation.

To install:

8. Replace any bushings that are not almost perfect. The two U-shaped bushings from the front brackets are particularly prone to deforming.
9. After replacing bushings as needed, reconnect the lower link to the arm on each side.
10. Hold the bar in position and install the front brackets with their bushings. Make sure the slot in the bushing faces forward.
11. Install the bar to the link on one side of the car but do not tighten more than two or three turns. Connect the bar to the link on the opposite side and install the bushings and nut.
12. Tighten each upper link nut until 1.65 in. (42mm) can be measured between the outer surfaces of the upper and lower washers.
13. Reinstall the underside splash panel if necessary, and install the wheel.
14. Lower the car to the ground and snug the wheel lugs.

Strut Rod

The front strut rods, also called the radius rod or control arm strut, serve to locate the lower control arm and prevent fore-and-aft movement. Except for impact damage, the rods rarely fail. The rubber bushings on each end are prone to fatigue and wear and may need to be replaced after a few years.

Loosen the rod-to-body bolt but don't remove it. Remove the nut at the control arm. This is sometimes easier said than done; the control arm bolt can be very tight. Once the front nut is loosened, the back mount may be removed and the rod placed on a workbench.

To install:

If the bushings are to be replaced, press them free of their mounts and install the new ones. Reinstall the rod, attaching the rear bolt first. Make sure the front bushings seat properly in the control arm and that the front nut draws tight against its washer.

Upper Control Arm

REMOVAL & INSTALLATION

➡On all models, always fully install the control arm, bounce the suspension several times, and THEN tighten the control arm-to-control arm shaft nuts.

1800 Series

1. Loosen the front wheel lugs, raise the car, support it on jackstands under the lower control arm and remove the wheel.
2. Remove the control arm-to-cross shaft nuts and clamps.
3. Remove the nuts at the spindle end, the bolts for the ball joint and lift off the control arm.

To install:

4. Position the new control arm and ball joint assembly. Fit the clamps and torque the nuts to 14-18 ft. lbs. (19-24 Nm).
5. Reassemble the other parts.

140 and 160 Series

1. Loosen the wheel lugs, raise the front end, support it on jackstands and remove the wheel.
2. Loosen, but do not remove, the upper ball joint nut. Remove the ball joint by tapping on the steering knuckle around the ball joint pin.
3. Remove the nut and suspend the upper end of the knuckle to avoid straining the brake hose.
4. Disconnect the control arm from the cross shaft. Take note of the number and position of the shims.

To install:

5. Place the new control arm in position and attach the bolts by hand. Fit the shims into their exact previous positions.
6. Tighten the nuts for the crosshaft to 40-45 ft. lbs. (54-61 Nm).
7. Reinstall the upper ball joint in the steering knuckle and tighten the nut.
8. Install the wheel. Lower the vehicle and tighten the lugs to 85-90 ft. lbs. (115-122 Nm).

Lower Control Arm

REMOVAL & INSTALLATION

➡On all models, always fully install the control arm, bounce the suspension several times, and THEN tighten the control arm to crossmember mounting nuts or bolts.

1800 Series

1. Loosen the wheel lugs, raise and support the front end and remove the wheels.
2. Remove the shock absorber.
3. Place a jack under the lower control arm at the spring. Raise the jack until the control arm rubber stop rises.
4. Disconnect the stabilizer bar from the lower control arm.
5. Remove the lower ball joint.
6. Slowly lower the jack and remove the spring when all tension is relieved.

✲✲CAUTION

The spring is under considerable pressure. The use of a spring compressor or safety chain is advised.

7. Disconnect the control arm from the cross shaft and remove.

To install:

8. Install the new arm on the cross shaft. Position the spring and raise the control arm into place.
9. Connect the lower ball joint and the stabilizer bar to the lower control arm.
10. Install the shock absorber.
11. Install the wheel, lower the car and tighten the wheel lugs.

140 Series and 164 Models

1. Loosen the wheel lugs, raise and support the car and remove the wheels.
2. Remove shock absorber.

3. Disconnect the tie rod from the steering arm with a separator tool.
4. Loosen the brake hose clamp and remove the stabilizer.
5. Place a jack under the lower control arm and support it.
6. Loosen the ball joint nuts and tap around the ball joints with a hammer until they loosen from the knuckle.
7. Remove the nuts, lower the jack slightly and remove the knuckle with the front brake unit. Suspend or position this assembly out of the way.
8. Lower the jack slowly and carefully and, when all tension is relieved, remove the spring.

✲✲CAUTION

The spring is under considerable pressure. It is advisable to use a spring compressor or safety chain when removing the spring.

9. Remove the control arm shaft nut, turn the relay rod with the tie rod (so that the control arm shaft is free) and remove the control arm shaft.
10. Remove the control arm.

To install:

11. Pay attention to the correct order of spacers, rings and washers on the shaft. Their order and placement is important. Install the control arm in place and tighten the nut to 95-110 ft. lbs. (130ndash;150 Nm).
12. Place the spring in position and elevate the arm with the jack.
13. Attach the steering knuckle and connect and tighten the ball joints.
14. Install the brake hose clamps. Connect the tie rod to the steering rod.
15. Reinstall the shock absorber.
16. Install the wheel, lower the car and tighten the lug nuts to 85-90 ft. lbs. (115-122 Nm).

240 and 260 Series

➧ See Figure 10

1. Jack up the car, support on stands and remove the wheels.
2. Disconnect the stabilizer (sway bar) link at the control arm.
3. Remove the ball joint from the control arm. (Helpful tips can be found in "Lower Ball Joint Removal and Installation" in this section.)
4. Remove the control arm rear attachment plate.
5. Remove the control arm front retaining bolt.
6. Remove the control arm.
7. If bushings are to be replaced, note that the right and left bushings are not interchangeable. The right side bushing should be turned so that the small slots point horizontally when installed.

To install:

8. Install the bracket onto the control arm. The nut should be tightened only enough to hold securely. The washer should be able to be turned with your fingers after the nut is on.
9. Attach the control arm. Install the front retaining bolt and nut; tighten the nut only two or three turns onto the bolt.
10. Guide the stabilizer link into position. Attach it loosely with its nut and bolt.

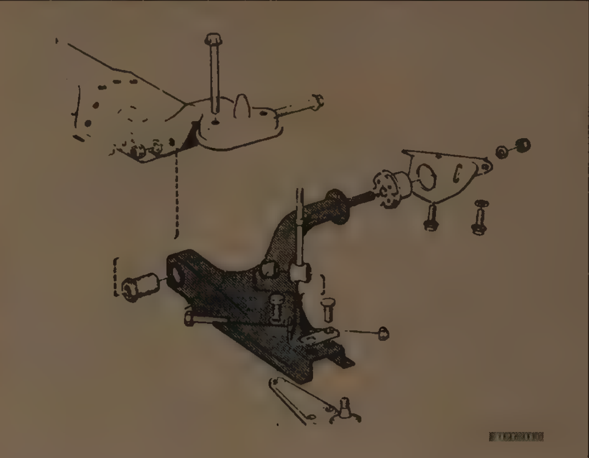


Fig. 10 Exploded view of the lower control arm and related fasteners — 200 series

11. Install the ball joint and its mount. Tighten the three mounting bolts to 75-95 ft. lbs. (102-129 Nm).
12. Install the rear bracket to the car. Tighten the three bolts to 25-35 ft. lbs. (34-47 Nm).
13. Tighten the stabilizer link.
14. Install the wheels and lower the car to the ground. Roll the car back and forth several times while bouncing the front end up and down. This "normalizes" the front suspension and allows the control arm to seek its final position.
15. Tighten the rear mount nut to 38-44 ft. lbs. (52-60 Nm). Tighten the front mount to 55 ft. lbs. (75 Nm).

700 Series

➧ See Figure 11

1. Jack the car, support it on jackstands and remove the wheel.
2. Remove the cotter pin from the ball joint and remove the ball joint nut.
3. Disconnect the stabilizer (sway bar) link at the control arm.
4. Disconnect the strut bolt and remove the front bushing.
5. Use a ball joint puller and separate the ball joint from the control arm. Make sure the puller is properly located and that the rubber boot is not damaged during removal.
6. Unbolt the control arm at the crossmember and remove the arm.

To install:

7. If the bushings are to be replaced, use a press and support the arm from below. The new bushings should always be pressed in from the front side of the arm.
8. Fit the control arm over the end of the strut rod. Install the arm in the crossmember but do not fully tighten the nut.
9. Install the ball joint in the control arm. Tighten the nut to 44 ft. lbs. (60 Nm). Install a new cotter pin.
10. Install the bushing, washer and bolt for the strut rod. tighten the bolt to 70 ft. lbs. (95 Nm).
11. Attach the stabilizer link to the control arm and tighten it to 63 ft. lbs. (85 Nm).
12. Install the wheels and lower the car to the ground. Roll the car back and forth several times while bouncing the front

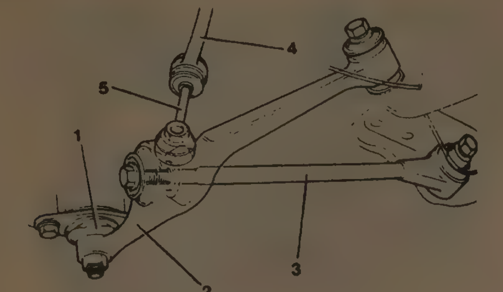


Fig. 11 Exploded view of the lower control arm and related fasteners — 700 series

end up and down. This "normalizes" the front suspension and allows the control arm to seek its final position.

13. Tighten the control arm-to-crossmember bolt to 63 ft. lbs. (85 Nm). Tighten the wheel lugs evenly to 63 ft. lbs. (85 Nm).

Front Wheel Bearings

REPLACEMENT

:::CAUTION

This procedure requires removal of the brakes. Brake pads and shoes may contain asbestos, which has been determined to a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling and dust from brake surfaces! When cleaning brakes, use commercially available brake cleaning fluids.

:::CAUTION

The use of the correct special tools or their equivalent is REQUIRED for this procedure.

All Models Except 700 Series

➧ See Figures 12, 13, 14, 15 and 16

1. Loosen the wheel nuts, elevate the car and safely support it with jackstands under the lower control arms.

2. Plug the vent hole in the brake fluid reservoir to prevent spillage and leakage.

3. Remove the wheels. Disconnect the brake hose at its joint to the metal pipe. Catch any spilled fluid and plug the open lines.

4. Remove the attaching bolts and remove the brake caliper. Note the position of any shims in the mounting.

5. Remove the grease cap. Remove the cotter pin, the castle nut and mount a hub puller onto the disc.

6. Pull the hub off. The outer bearing will come off with it; the inner bearing may stay on the stub axle. If this happens, simply use a bearing puller of the correct size to remove the bearing from the axle.

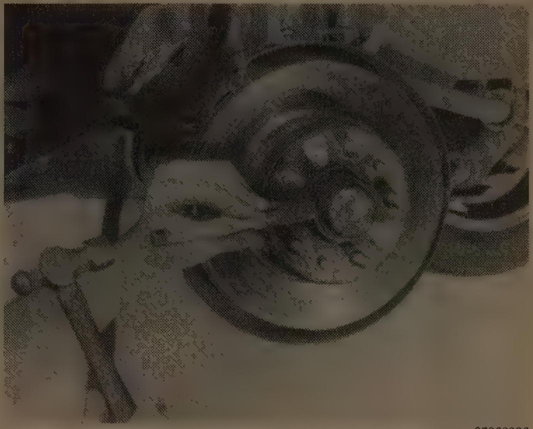


Fig. 12 Remove the dust cap by prying it outwards with a chisel and hammer

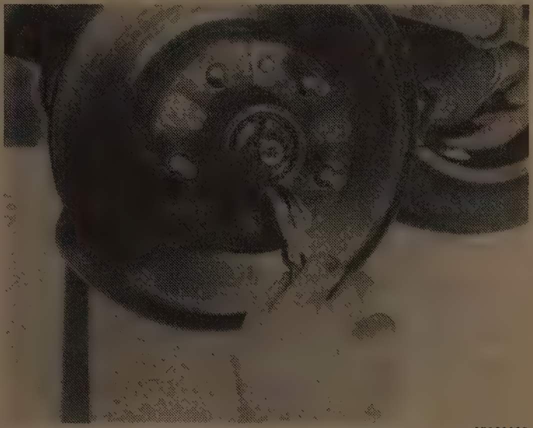


Fig. 13 Remove the cotter pin from the castellated axle nut

7. Remove the brake disc from the hub. Bearings can now be inspected and cleaned. Clean all the components thoroughly, including the inside of the hub. Every trace of the old grease must be removed.

8. After cleaning, inspect all the parts. Look carefully for any signs of imperfect surfaces, cracking, bluing or looseness. Check the matching surface or race on which the rollers run. Any sign of imperfection requires replacement.

9. After the bearings have been cleaned, inspected and are totally dry, repack them using a quality bearing or multi-purpose grease. Each bearing must be fully packed; the use of a bearing packer is highly recommended although the job can be done by hand if close attention is paid.

10. The space inside the hub should also be packed; remember that the stub axle comes through here — don't pack it solid.

11. If it is necessary to replace the races, they should be removed from the hub using tools which match the full diame-

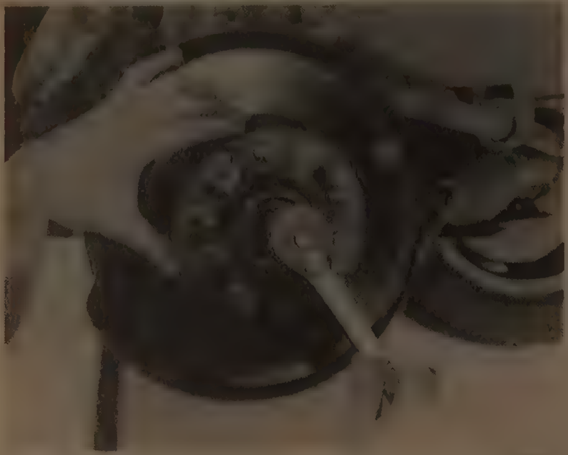


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Fig. 14 Use the correct socket to remove the axle nut

ter of the race. Use of a punch or drift may cause damage. The seals, made of pressed felt, should be soaked in light engine oil before installation.

12. Place the inner bearing in position within the hub. Using the correct sized drift, install the inner seal.
13. Install the hub onto the stub axle and fit the outer bearing in place. Install the washer and castle nut.
14. Adjust the front wheel bearings by spinning the hub and simultaneously tightening the center nut to 50 ft. lbs. (68 Nm). Then loosen the center nut two flats on the center nut. If the nut recess (groove) doesn't line up with the cotter pin hole, loosen the nut just a bit until it aligns. Install a new cotter pin and check that the hub spins freely without excess sideplay.
15. Install the brake disc on the hub.
16. Fill the grease cap half full with bearing grease and install the cap.
17. Reinstall the caliper, observing shim placement as noted during removal.
18. Remove the plugs and connect the brake lines.
19. Bleed the brakes and remove the plug from the reservoir vent hole.

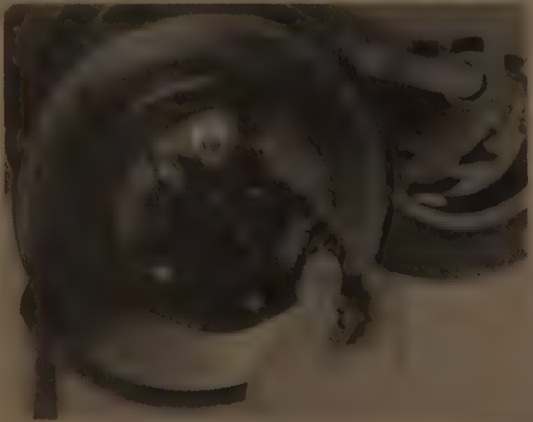

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Fig. 15 Remove the outer bearing and related hardware once the nut is removed

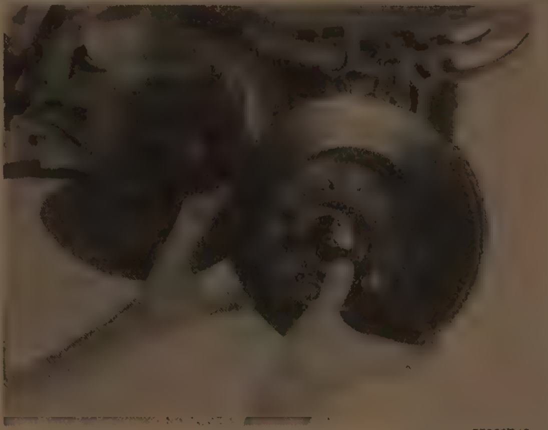

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Fig. 16 Remove the brake disc from the axle shaft — the inner bearing is held in the assembly

20. Install the wheel and lower the vehicle to the ground. Final tighten the wheel lugs.

700 Series

1. Safely elevate and support the front end. Remove the wheel.
2. Loosen the retaining bolts and remove the brake caliper. Hang the caliper out of the way with a piece of stiff wire.
3. Pry off the grease cap. Remove the cotter pin and castle nut.
4. Remove the brake disc. The outer bearing will come off with the disc. Use a bearing puller to remove the inner bearing from the spindle if it is difficult to remove.

➡On 1988-89 760 and 780 cars with Multi-link rear suspension, the brake disc will be a separate item. Removing the disc will expose the hub locknut, which must also be removed. Both wheel bearings are found inside the hub.

5. With the disc supported on blocks of wood, remove the inner seal with a seal puller, then remove the inner bearing race with a long brass punch.
6. Remove the outer race with the use of the proper size driver. The bearings can now be inspected and cleaned.
7. Clean all the components thoroughly, including the inside of the disc. Every trace of the old grease must be removed.
8. After cleaning, inspect all the parts. Look carefully for any signs of imperfect surfaces, cracking, bluing, rust or looseness. Check the matching surface or race on which the rollers run. Any sign of imperfection requires replacement.
9. After the bearings have been cleaned, inspected and are totally dry, repack them using a quality bearing or multi-purpose grease. Each bearing must be fully packed; the use of a bearing packer is highly recommended although the job can be done by hand if close attention is paid.
10. The space inside the disc should also be packed; remember that the spindle comes through here — don't pack it solid.
11. If the races were removed, install them into the disc using drivers of proper size. Make sure they install straight and are not cocked or out of place. For 1988-89 760 and 780 with

Multi-link rear suspension, the bearings install into the hub, not the disc.

12. Install the inner bearing with a new seal into the brake disc or hub. Smear the seal lip with grease.

13. Install the disc, the outer bearing and the castle nut. For 1988-89 760 and 780 with Multi-link rear suspension, install the hub and with a NEW locknut. Do not reuse the old nut; bearing damage may result. Tighten the new nut to 74 ft. lbs. (100 Nm) PLUS an additional 45° of rotation.

14. Install the brake caliper. Volvo recommends the use of new retaining bolts. The bolts should be tightened to 74 ft. lbs. (100 Nm).

15. Adjust the front wheel bearing by spinning the disc several times and then tightening the nut to 42 ft. lbs. (57 Nm). Loosen the nut ½ turn, then retighten to 12 inch lbs. (1.3 Nm). This is just enough to hold the bearing in place but not enough to develop any side loading.

16. Install a new cotter pin. If the hole in the spindle doesn't align with the castle nut, tighten the nut just until the hole and slot align.

17. Install the grease cap. Install the wheel.

18. Lower the car to the ground and tighten the wheel to 63 ft. lbs. (85 Nm).

Spindle (Stub Axle)

REMOVAL & INSTALLATION

****CAUTION**

This procedure requires removal of the brakes. Brake pads and shoes may contain asbestos, which has been determined to a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling and dust from brake surfaces! When cleaning brakes, use commercially available brake cleaning fluids.

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure.

1800 Series

1. Loosen the wheel nuts, elevate the car and safely support it with jackstands under the lower control arms.
2. Plug the vent hole in the brake fluid reservoir to prevent spillage and leakage.
3. Remove the wheels. Disconnect the brake hose at its joint to the metal pipe. Catch any spilled fluid and plug the open lines.
4. Remove the attaching bolts and remove the brake caliper. Note the position of any shims in the mounting.
5. Remove the grease cap. Remove the cotter pin, the castle nut and mount a hub puller onto the disc.
6. Pull the hub off. The outer bearing will come off with it; the inner bearing may stay on the stub axle. If it does, simply use a bearing puller of the correct size to remove the bearing from the axle.
7. Remove the four bolts and separate the splash shield, retainer and steering arm from the knuckle.
8. Loosen and remove the upper and lower ball joints.
9. Lift out the stub axle and steering knuckle assembly.

To install:

10. Since the wheel bearings have been removed and exposed, they should be cleaned and repacked before reinstallation. When reassembling, fit the stub axle into position and and attach the upper and lower ball joints.
11. Assemble and connect the retainer, steering arm and splash shield to the steering knuckle/stub axle assembly.
12. Place the inner bearing in position within the hub. Using the correct sized drift, install the inner seal.
13. Install the hub onto the stub axle and fit the outer bearing in place. Install the washer and castle nut.
14. Adjust the front wheel bearings by spinning the hub and simultaneously tightening the center nut to 50 ft. lbs. (68 Nm). Then loosen the center nut two flats on the center nut. If the nut recess (groove) doesn't line up with the cotter pin hole, loosen the nut just a bit until it aligns. Install a new cotter pin and check that the hub spins freely without excess sideplay.
15. Install the brake disc on the hub.
16. Fill the grease cap half full with bearing grease and install the cap.
17. Reinstall the caliper, observing shim placement as noted during removal.
18. Remove the plugs and connect the brake lines.
19. Bleed the brakes and remove the plug from the reservoir vent hole.
20. Install the wheel and lower the vehicle to the ground. Final tighten the wheel lugs.

140 and 160 Series

1. Safely elevate and support the car on jackstands. Remove the front wheel.
2. Remove the front brake caliper; use stiff wire and hang the caliper out of the way.
3. Remove the grease cap. Remove the cotter pin, the castle nut and mount a hub puller onto the disc.
4. Pull the hub off. The outer bearing will come off with it; the inner bearing may stay on the stub axle. If this happens, simply use a bearing puller of the correct size to remove the bearing race from the axle.
5. Use a ball joint separator and remove the steering rod from the steering arm. Volvo tool 2294 is recommended.
6. Loosen, but do not remove, the nuts for the ball joints. Tap on the housing with a hammer until the ball joint shafts loosen in their mounts.
7. Use a floor jack and elevate the control arm slightly. Remove the nuts for the ball joints and remove the steering knuckle/stub axle assembly.

To install:

8. Since the wheel bearings have been removed and exposed, they should be cleaned and repacked before reinstallation. When reassembling, fit the stub axle into position and and attach the upper and lower ball joints.
9. Attach the steering rod onto the steering arm.
10. Place the inner bearing in position within the hub. Using the correct sized drift, install the inner seal.
11. Install the hub onto the stub axle and fit the outer bearing in place. Install the washer and castle nut.
12. Adjust the front wheel bearings by spinning the hub and simultaneously tightening the center nut to 50 ft. lbs. (68 Nm). Then loosen the center nut two flats on the center nut. If the

nut recess (groove) doesn't line up with the cotter pin hole, loosen the nut just a bit until it aligns. Install a new cotter pin and check that the hub spins freely without excess sideplay.

13. Install the brake disc on the hub.
14. Fill the grease cap half full with bearing grease and install the cap.
15. Reinstall the caliper.
16. Install the wheel and lower the vehicle to the ground. Final tighten the wheel lugs.

200 Series

✲✲CAUTION

This procedure requires removal of the brakes. Brake pads and shoes may contain asbestos, which has been determined to a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling and dust from brake surfaces! When cleaning brakes, use commercially available brake cleaning fluids.

➡The use of the correct special tools or their equivalent is REQUIRED for this procedure. To remove the spring, a coil spring compressor must be used. Under no circumstances should you attempt to lower and disassemble the strut assembly without the proper spring compressor. Serious injury could result.

1. Loosen the wheel nuts, elevate the car and safely support it with jackstands under jack points or frame.
2. Plug the vent hole in the brake fluid reservoir to prevent spillage and leakage.
3. Remove the wheels. Disconnect the brake line bracket but don't disconnect the hoses.
4. Remove the attaching bolts and remove the brake caliper. Note the position of any shims in the mounting. Use wire to support the caliper out of the way.
5. Remove the grease cap. Remove the cotter pin, the castle nut and mount a hub puller onto the disc.
6. Pull the hub off. The outer bearing and disc will come off with it; the inner bearing may stay on the stub axle. If this happens, simply use a bearing puller of the correct size to remove the bearing from the axle.
7. Place a floor jack beneath the control arm to support it but do not locate it under the lower ball joint.
8. Install the spring compressor on the spring directly beneath the upper mount. Make sure that at least 3 coils of the spring are between the tool attachment points. Tighten the tool and compress the spring.
9. Using a ball joint puller, disconnect the steering rod from the steering arm.
10. Disconnect the stabilizer bar at the upper link.
11. Open the hood and remove the cover from the top of the strut assembly upper mount. Mark the position of the upper mounts relative to their holes.
12. While keeping the strut from turning, loosen and remove the nut for the upper strut mount.
13. Before lowering the strut assembly, wire or tie the strut to some stationary component (or use a holding fixture such as Volvo No. 5045) to prevent the strut from traveling down too far. Lower the jack supporting the lower arm and allow the strut to tilt out at about a 60° angle. At this angle, the top of the strut assembly should just protrude past the wheel well, allowing removal of the strut components from the top. Take great care to control the descent of the strut and prevent damage to the fender.
14. Lift off the spring seat, rubber bumper, and the shock absorber protector. Remove the coil spring and compressor assembly from the strut.
15. If the same spring is to be reused, it may be left within the compressor and put aside until reassembly.
16. While keeping the strut outer tube from turning, remove the upper shock absorber retaining nut.
17. Pull the shock absorber unit out of the outer tube (casing).

➡On some models, gas type shock absorbers are used. A special tool (such as Volvo No. 5173 or similar) must be used to remove and install the unit.

18. Remove the lower ball joint nut and mount. Please consult the section in this section for "Lower Ball Joint Removal and Installation" for specific instructions regarding early or later production cars.
19. With the lower ball joint disconnected, the strut assembly may be removed from the car. It is a one piece assembly consisting of the shock absorber tube, the lower spring seat and the spindle (stub axle). The components are not individually replaceable; any failure requires a complete replacement unit.

To install:

20. Position the new unit and install the lower ball joint, following the correct procedure for early or late production cars. Support the upper part of the assembly as before to prevent damage.
21. Install the shock absorber unit into the outer tube and install the retaining nut. You can stop the outer tube from turning with the nut by holding the tube at the weld with a pair of locking pliers.
22. Pull the shock absorber shaft to its uppermost position.
23. Position the spring and compressor on the strut assembly. Make sure the spring end is properly aligned with the lower mount.
24. Install the rubber bumper and the shock absorber protector. Position the spring seat on the spring, making sure it is aligned with the spring.
25. Carefully lift and guide the strut assembly into its upper attachment in the spring tower. Connect the stabilizer bar to the stabilizer link.
26. Guide the shock absorber spindle into the upper attachment and raise the jack beneath the lower control arm. Install the washer and nut on top of the shock absorber spindle. Position the upper mount according to marks made during removal. Tighten the upper mounting bolts. The smaller outer nuts should be tightened to 15-25 ft. lbs. (20-34 Nm). The large center nut should be tightened to 90-100 ft. lbs. (122-135 Nm).
27. Install the cover.
28. Attach the brake line bracket to its mount. Make sure that the brake lines sit properly in their mounts. Tighten the nut holding the stabilizer bar to the link. Connect the steering rod at the steering arm.
29. Slowly release the coil spring compressor, allow the spring to seat and remove the compressor.
30. Inspect the front wheel bearings as outlined under "Front Wheel Bearings Removal and Installation" in this section.

Repack the bearings if necessary and always replace the seals.

31. Place the inner bearing in position within the hub. Using the correct sized drift, install the inner seal.

32. Install the hub onto the stub axle and fit the outer bearing in place. Install the washer and castle nut.

33. Adjust the front wheel bearings by spinning the hub and simultaneously tightening the center nut to 50 ft. lbs. (68 Nm). Then loosen the center nut two flats on the center nut. If the nut recess (groove) doesn't line up with the cotter pin hole, loosen the nut just a bit until it aligns. Install a new cotter pin and check that the hub spins freely without excess sideplay.

34. Install the brake disc on the hub.

35. Fill the grease cap half full with bearing grease and install the cap.

36. Reinstall the caliper, observing shim placement as noted during removal.

37. Reinstall the brake hose mounting bracket. Check that the brake lines are not stretched or kinked.

38. Remove the jack from under the control arm. Remove the plug from the reservoir vent hole.

39. Install the wheel and lower the vehicle to the ground. Final tighten the wheel lugs.

700 Series

➧ See Figure 17

1. Safely elevate and support the front end. Remove the wheel.

2. Loosen the retaining bolts and remove the brake caliper. Hang the caliper out of the way with a piece of stiff wire.

3. Pry off the grease cap. Remove the cotter pin and castle nut.

4. Remove the brake disc. The outer bearing will come off with the disc. Use a bearing puller to remove the inner bearing from the spindle if it is difficult to remove.

➡On 1988-89 760 and 780 cars with Multi-link rear suspension, the brake disc will be a separate item. Removing the disc will expose the hub locknut, which must be removed. Both wheel bearings are found inside the hub.

5. Position a jack under the lower control arm to support it, but don't place it under the lower ball joint.

6. Install the spring compressor on the spring directly beneath the upper mount. Make sure that at least 3 coils of the spring are between the tool attachment points. Tighten the tool and compress the spring.

7. Using a ball joint puller, disconnect the steering rod from the steering arm.

8. Disconnect the stabilizer bar at the upper link.

9. Remove the bolt holding the brake line bracket to the fender well.

10. Open the hood and remove the cover from the top of the strut assembly upper mount. Mark the position of the upper mounts relative to their holes.

11. While keeping the strut from turning, loosen and remove the nut for the upper strut mount.

12. Before lowering the strut assembly, wire or tie the strut to some stationary component (or use a holding fixture such as Volvo No. 5045) to prevent the strut from traveling down too far and causing damage. Lower the jack supporting the lower arm and allow the strut to tilt out at about a 60° angle. At this angle, the top of the strut assembly should just protrude past the wheel well, allowing removal of the strut components from the top. Take great care to control the descent of the strut and prevent damage to the fender.

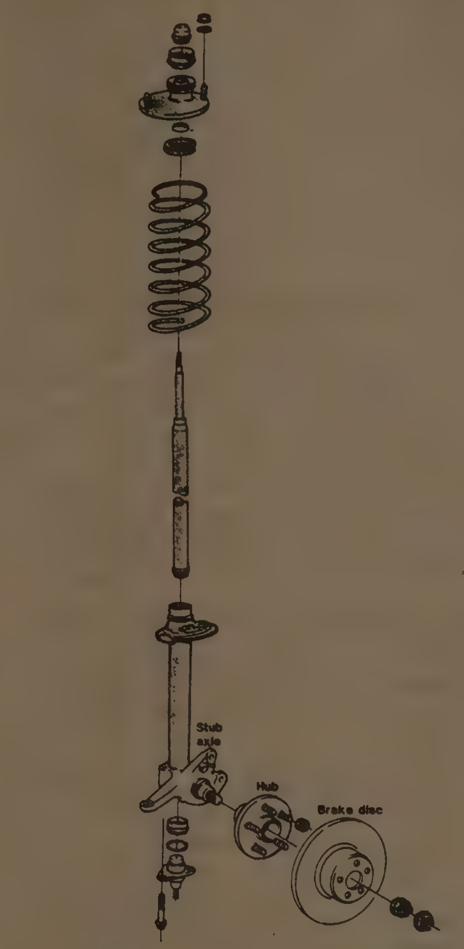

Fig. 17 Exploded view of the front hub and stub axle assembly (including the strut assembly) — 700 series with multi-link suspension

13. Lift off the spring seat, rubber bumper, and the shock absorber protector. Remove the upper spring mount from the shaft. If the same spring is to be reinstalled, it may be left within the compressor and put aside.

14. While keeping the strut outer tube from turning, remove the upper shock absorber retaining nut.

15. Pull the shock absorber unit out of the outer tube (casing).

➡On some models, gas type shock absorbers are used. A special tool (such as Volvo No. 5173 or similar) must be used to remove and install the unit.

16. Remove the cotter pin for the lower ball joint stud, and remove the nut.

17. Using a ball joint separator, press out the ball joint from the control arm. Make sure the puller is located directly in line

with the stud, and that the rubber grease boot is not damaged by the puller.

18. Remove the bolts holding the ball joint to the spring strut. Press the control arm down and remove the ball joint.
19. With the lower ball joint disconnected, the strut assembly may be removed from the car. It is a one piece assembly consisting of the shock absorber tube, the lower spring seat and the spindle (stub axle). The components are not individually replaceable; any failure requires a complete replacement unit.

To install:

20. Position the new unit and install the lower ball joint. tighten the retaining nut to 44 ft. lbs. (60 Nm). Support the upper part of the assembly as before to prevent damage.
21. Install the shock absorber unit into the outer tube and install the retaining nut. You can stop the outer tube from turning with the nut by holding the tube at the weld with a pair of locking pliers.
22. Pull the shock absorber shaft to its uppermost position.
23. Position the spring and compressor on the strut assembly. Install the upper spring mount. Make sure the spring end is properly aligned with the lower mount.

➡Make sure that the compressor bolts face as they did during removal.

24. Install the rubber bumper and the shock absorber protector. Position the spring seat on the spring, making sure it is aligned with the spring.
25. Carefully lift and guide the strut assembly into its upper attachment in the spring tower. Connect the stabilizer bar to the stabilizer link.
26. Guide the shock absorber spindle into the upper attachment and raise the jack beneath the lower control arm. Install the washer and nut on top of the shock absorber spindle. Position the upper mount according to marks made during removal. Tighten the upper mounting bolts. The smaller outer nuts should be tightened to 15-25 ft. lbs. (20-34 Nm). The large center nut should be tightened to 90-100 ft. lbs. (122-135 Nm). Install the cover.
27. Attach the brake line bracket to its mount. Make sure that the brake lines sit properly in their mounts. Tighten the nut holding the stabilizer bar to the link. Connect the steering rod at the steering arm.
28. Slowly release the coil spring compressor and remove it from the car.
29. Inspect the front wheel bearings as outlined under "Front Wheel Bearings — Removal and Installation" in this section. Repack the bearings if necessary and always replace the seals.
30. Place the inner bearing in position within the hub or disc. Using the correct sized drift, install the inner seal.
31. Install the disc, the outer bearing and the castle nut. For 1988-89 760 and 780 with Multi-link rear suspension, install the hub and with a NEW locknut. Do not reuse the old nut; bearing damage may result. Tighten the new nut to 74 ft. lbs (100 Nm) PLUS an additional 45° of rotation.
32. Install the brake caliper. Volvo recommends the use of new retaining bolts. The bolts should be tightened to 74 ft. lbs. (100 Nm).
33. Adjust the front wheel bearing by spinning the disc several times and then tightening the nut to 42 ft. lbs. (57 Nm). Loosen the nut ½ turn, then retighten to one ft. lb. This is just enough to hold the bearing in place but not enough to develop any side loading.
34. Install a new cotter pin. If the hole in the spindle doesn't align with the castle nut, tighten the nut just until the hole and slot align.
35. Install the grease cap. Install the wheel.
36. Lower the car to the ground and tighten the wheel to 63 ft. lbs. (85 Nm).

Front End Alignment

Alignment of the front wheels is essential if your car is to go, stop and turn as designed. Alignment can be altered by collision, overloading, poor repair or bent components.

If you are diagnosing bizarre handling and/or poor road manners, the first place to look is the tires. Although the tires may wear as a result of an alignment problem, worn or poorly inflated tires can make you chase alignment problems which don't exist.

Once you have eliminated all other causes, unload everything from the trunk except the spare tire, set the tire pressures to the correct level and take the car to a reputable alignment facility. Since the alignment settings are measured in very small increments, it is almost impossible for the home mechanic to accurately determine the settings. The explanations that follow will help you understand the three dimensions of alignment: caster, camber and toe.

CASTER

Caster is the tilting of the steering axis either forward or backward from the vertical, when viewed from the side of the vehicle. A backward tilt is said to be positive and a forward tilt is said to be negative. Changes in caster affect the straight line tendency of the vehicle and the "return to center" of the steering after a turn. If the camber is radically different between the left and right wheels (such as after hitting a major pothole), the car will exhibit a nasty pull to one side.

On the 140, 160 and 1800 series Volvos, caster is adjustable through the use of shims which reposition the suspension components in the correct direction. The later 200 and 700 series Volvos do not allow adjustment; replacement of bent components is required.

CAMBER

Camber is the tilting of the wheels from the vertical (leaning in or out) when viewed from the front of the vehicle. When the wheels tilt outward at the top, the camber is said to be positive. When the wheels tilt inward at the top the camber is said to be negative. The amount of tilt is measured in degrees from the vertical. This measurement is called camber angle.

Camber affects the position of the tire on the road surface during vertical suspension movement and cornering. Changes in camber affect the handling and ride qualities of the car as well as tire wear. Many tire wear patterns indicate camber related problems from misalignment, overloading or poor driving habits.

Camber is adjustable on the 100, 200, and 1800 series Volvos. On the 700 series, the position is fixed by the correct location of the suspension components. Any camber reading outside of specification requires replacement of bent parts.

TOE

Toe is the turning in or out (parallelism) of the wheels. The actual amount of toe setting is normally only a fraction of an inch. The purpose of toe-in (or out) specification is to ensure parallel rolling of the wheels. Toe-in also serves to offset the small deflections of the steering support system which occur when the vehicle is rolling forward.

Changing the toe setting will radically affect the overall "feel" of the steering, the behavior of the car under braking, tire wear and even fuel economy. Excessive toe (in or out) causes excessive drag or scrubbing on the tires.

Toe is adjustable on all Volvos. It is generally measured in decimal inches or degrees. It is adjusted by loosening the locknut on each tie rod end and turning the rod until the correct reading is achieved. The rods left and right must remain equal in length during all adjustments.

Wheel Alignment

Year	Model	Caster Range (deg)	Camber Range (deg)	Toe-in (in.)	Steering Axis Inclination (at 0° camber)	Wheel Pivot Ratio (deg) Inner Wheel	Wheel Pivot Ratio (deg) Outer Wheel
1970–71	140 series 164	0–1P	0–½P	0–0.16	7.5	20	21.5–23.5
1970–71	1800 series	0–1P	0–½P	0–0.16	8.0	20	21.5–23.5
1972	140 series 164	0–1P	0–½P	0.080–0.20	7.5	20	21.5–23.5
1972–73	1800 series	①	0–½P	0–0.12	8.0	20	21.5–23.5
1973	140 series 164	1½P–2P	0–½P	0.08–0.20	7.5	20	21.5–23.5
1974	140 series, 164	1½P–2½P ②	0–½P	0–0.063	7.5	20	21.5–23.5
1975	240 series	2P–3P	1P–1½P	③	12	20	20.8
1975	164	½P–1½P	¾N–1¼N	0.063–0.188	7.5	20	21.5–23.5
1976–77	240 series, 260 series	2P–3P	1P–1½P	0.18–0.30	12	20	20.8
1978	240, 260 series	2P–3P	1P–1½P	0.12–0.24 ④	12	20	20.8
1979	240, 260 series	2P–3P ⑤	0–1N ⑥	0.12–0.24 ④	12	20	20.8
1980–83	All models except GLT, 760 GLE	2P–3P ⑤	1P–1½P	0.18–0.24 ⑦	12	20	20.8
1980–83	GLT	2P–3P ⑤	¼P–¾P	0.18–0.24 ⑦	12	20	20.8
1983	760 GLE	5P	¹³⁄₃₂P	0.10–0.18	—	—	—
1984	DL, GL	3P–4P	1P–1½P ⑥	0.06–0.18	12	20	20.8
1984	GLT, GLE	3P–4P	¼–¾P ⑥	0.06–0.18	12	20	20.8
1984–87	740, 760, 780 series	4½–5½	²⁄₁₀N–⁸⁄₁₀P	0.10–0.18	—	—	—
1985–89	240 series all models	3P–4P	¼P–¾P ⑥	0.06–0.18	12	20	20.8
1988–89	760, 780	4½P–5½P	²⁄₁₀N–⁸⁄₁₀P	0.00–0.025	—	—	—

P Positive N Negative
① 0–1P—165HR15 Tires
2P–2½P—185/70HR15 Tires
② w/power steering, caster is 2P–3P
③ w/manual steering—0.171–0.183 in.
w/power steering—0.114–0.126 in.
④ Power steering—0.06–0.18
⑤ Power steering—3P–4P
⑥ Must not exceed ½° difference between sides
⑦ Power steering—0.12–0.18 in.

REAR SUSPENSION

See Figure 18

All Volvos, except the 1988-89 760 and 780, use a coil spring rear suspension. The solid rear axle is suspended from the rigid frame member by a pair of support arms and damped by a pair of double-acting telescopic shock absorbers. A pair of torque rods control rear axle wind-up and a track rod limits the lateral movement of the rear axle in relation to the car. A rear stabilizer bar, attached to both rear support (trailing) arms, is installed on certain models.

In 1988, the 760 4 door sedan and the 780 model introduced Volvo's Multi-link suspension system. This independently suspends each rear wheel, allowing improved ride and road holding as well as allowing each rear wheel to be aligned separately. The rear suspension is two-way adjustable, allowing setting of camber and toe at the rear wheels. Caster is fixed by the design of the suspension and cannot be altered except by replacement of damaged parts.

Multi-link suspensions require alignment any time the suspension components are removed and installed. Position of components is critical as are torque values when retightening bolts. Multi-link repairs are discussed separately at the end of this section.

Coil Springs

REMOVAL & INSTALLATION

140, 160 and 200 Series

➧ See Figures 19 and 20

✲✲CAUTION

The use of the correct special tools or their equivalent is REQUIRED for this procedure. To remove the spring, a coil spring compressor must be used. Under no circumstances should you attempt to remove the spring without the proper spring compressor. Serious injury could result.

1. Raise and safely support the rear of the vehicle. Remove the rear wheel.
2. Place a hydraulic jack beneath the rear axle housing and raise the housing sufficiently to compress the spring. Install the spring compressor and tighten it to hold the spring in its compressed position. Make sure there are at least three coils of spring between the attachment points of the compressor. Loosen the nuts for the upper and lower spring attachments.

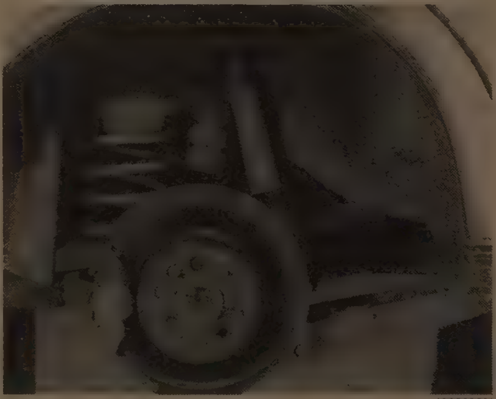

Fig. 18 A common 200 series rear suspension: separate coil spring, damper and bump stop mounted to a (pivoting) trailing arm

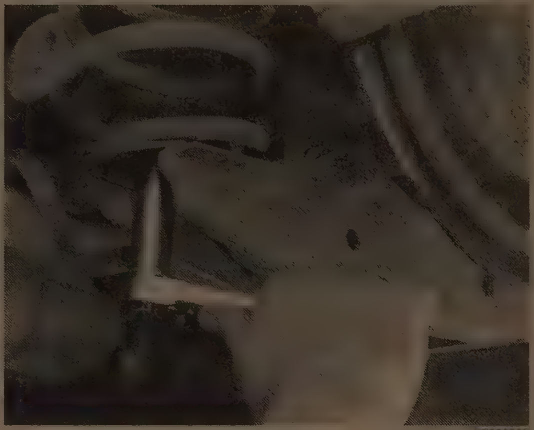

Fig. 19 Loosen the fasteners from beneath (shown) and above the spring

Fig. 20 Remove the lower hardware as shown

✲✲CAUTION

The spring is compressed under several hundred pounds of pressure! When it is freed from its lower attachment, it will attempt to suddenly return to its extended position. It is therefore imperative that the axle housing be lowered with extreme care until the spring is extended. As an added safety measure, a chain may be attached to the lower spring coil and secured to the axle housing.

3. Disconnect the shock absorber at its upper attachment. Carefully lower the jack and axle housing until the spring is extended. Remove the spring.

To install:

4. Position the retaining bolt and inner washer for the upper attachment inside the spring. While holding the outer washer and rubber spacer to the upper body attachment, in-

stall the spring and inner washer to the upper attachment (sandwiching the rubber spacer). Tighten the retaining bolt.

5. Raise the jack and secure the bottom of the spring to its lower attachment with the washer and retaining bolt. Slowly remove the spring compressor.

6. Connect the shock absorber to its upper attachment. Install the wheel.

7. Remove the jackstands and lower the car. Tighten the lug nuts to 85-90 ft. lbs. (115-122 Nm) and install the hub cap.

1800 Series

1. Remove the hub cap and loosen the lug nuts two or three turns. Place blocks in front of the front wheels. Jack up the rear of the car and place jackstands in front of the rear jacking points.

2. Remove the wheel and release the parking brake.

3. Place a hydraulic jack beneath the rear axle housing and raise the jack and axle housing sufficiently to unload the downward travel limiter (shock absorber band). Install the spring compressor and tighten it enough to hold the spring in a partially compressed position.

4. Disconnect the shock absorber at its lower attachment. Also disconnect the suspension travel limiter (shock absorber band) at its upper attachment.

✻✻CAUTION

Do not attempt to remove the spring until it is extended. As an added safety measure, a chain may be attached to the lower spring coil and secured to the axle housing.

5. Carefully lower the jack and axle housing until the spring is extended. Remove the spring and rubber spacer.

To install:

6. Fit the rubber spacer to the top of the spring and position the spring into it upper attachment. Secure the bottom of the spring into its lower attachment, making sure that the rubber cushion on the axle housing is positioned correctly.

7. Raise the jack sufficiently so that the shock absorber may be connected to its lower attachment. Connect the suspension travel limiter to its upper attachment. Slowly remove the spring compressor.

8. Install the wheel and tire assembly. Remove the jackstands and lower the car. Tighten the lug nuts to 85-90 ft. lbs. (115-122 Nm), and install the hub cap.

700 Series Except Multi-link Suspension

➧ See Figure 21

1. Loosen the lug nuts two or three turns. Place blocks in front of the front wheels. Jack up the rear of the car and place jackstands in front of the rear jacking points.

2. Remove the wheel. Remove the rear caliper and support it out of the way with a piece of wire. Do not allow it to hang by its hose.

3. Place a jack under the rear axle and elevate the axle just enough to take the tension off the lower shock absorber mount.

4. As a safety precaution, install a spring compressor on the spring and tighten it enough to hold it in a partially compressed position. Loosen and remove the lower shock absorber bolt.

5. Lower the rear axle to unload the spring. Remove the upper bolt, washers and rubber spacer. Remove the spring.

To install:

6. Fit the rubber spacer and washer to the new spring. Make sure that the recess in the spacer is properly seated.

7. Press and secure the lower washer to the rubber spacer.

8. Attach the spring to the upper mount. Tighten the nut to 35 ft. lbs. (47 Nm). Position the spring in the lower (trailing) arm.

9. Raise the rear axle with the jack and install the lower shock absorber bolt. Tighten it to 63 ft. lbs. (85 Nm).

10. Use new mounting bolts and install the rear brake caliper. Tighten the mounting bolts to 43 ft. lbs. (58 Nm), then install the wheel and lower the car to the ground. Final tighten the lugs to 63 ft. lbs. (85 Nm).

Shock Absorbers

REMOVAL & INSTALLATION

140, 160 and 200 Series

➧ See Figures 22, 23, 24, 25 and 26

1. Remove the hub cap and loosen the lug nuts two or three turns. Place blocks in front of the front wheels. Jack up the rear of the car and place jackstands in front of the rear jacking points. Remove the wheel.

2. Remove the nuts and bolts which retain the shock absorber to its upper and lower attachments and remove the shock absorber. Make sure that the spacing sleeve (inside the axle support arm for the lower attachment) is not misplaced.

3. The damping effect of the shock absorber may be tested by securing the lower attachment in a vise and extending and compressing it. A properly operating shock absorber should offer about three times as much resistance to extending the unit as to compressing it. Replace the shock absorber if any impaired function is found. Also replace it if any leakage is present or if the rubber bushings are damaged.

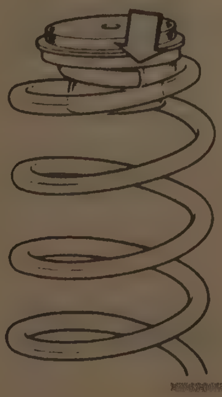

Fig. 21 Make sure the lower washer is secure against the upper spacer — 700 series

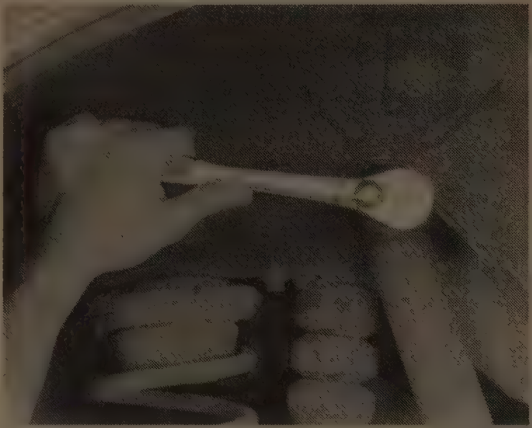
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Fig. 22 Use a wrench with sufficient leverage to remove the upper shock absorber mounting nut

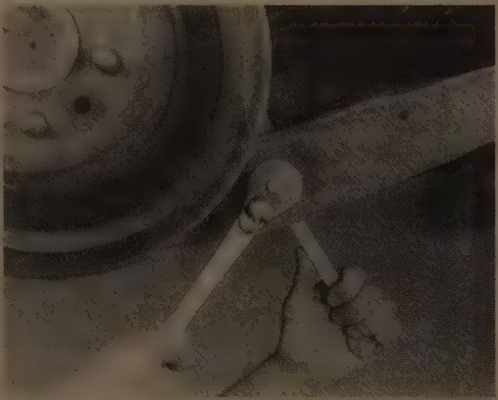
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Fig. 23 Use a wrench to prevent the bolt from turning while you remove the nut retaining the lower mounting hardware

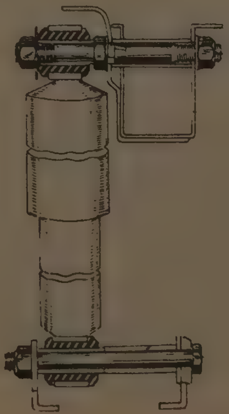
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Fig. 24 Cutaway view of the rear shock absorber and its mounting points — 200 series

87868351

Fig. 25 Once detached, remove the through-bolt that serves as the lower shock pivot

87868308

Fig. 26 Once free, remove the shock absorber from the vehicle

To install:

4. Position the shock absorber to its upper and lower attachments. Make sure that the spacing sleeve is installed inside the axle support (trailing) arm and is aligned with the lower attachment bolt hole.
5. Install the retaining nuts and bolts and tighten to 63 ft. lbs. (85 Nm). On 240 and 260 series, the shock fits inside the support arm. On all 140 and 164 models, the shock attaches on the outboard side of the support arm.
6. Install the wheel and tire assembly. Remove the jackstands and lower the car. Tighten the lug nuts to 85-90 ft. lbs. (115-122 Nm), and install the hub cap.

1800 Series

1. Fold the rear seat back forward. On 1800E models, remove the upholstery for the shelf under the rear window, and on 1800ES models fold back the carpet for the cargo bed, which will reveal the shock absorber upper attaching points.
2. Remove the upper nut, washers, and outer rubber bushing from the top of the shock absorber.

3. Under the car, remove the lower nut, washer, and outer rubber bushing from the bottom of the shock absorber.
4. Compress and remove the shock absorber.
5. Test the damping action of the shock absorber. Extending the unit should offer about three times as much resistance as compressing the unit. If the shock absorber is operating properly and is being reinstalled, be sure to use new rubber bushings.

To install:

6. Install inner washers and new rubber bushings, if removed, on the unit. Compress the shock absorber and position it to its upper and lower attachments.
7. Install the outer nut, washers, and new rubber bushings first to the top and then to the bottom of the shock absorber.
8. Replace the package shelf upholstery or the cargo bed carpet to its original position.

700 Series Except Multi-link Suspension

1. Loosen the lug nuts two or three turns. Place blocks in front of the front wheels. Jack up the rear of the car and place jackstands in front of the rear jacking points.
2. Remove the wheel. (While not absolutely necessary, access is improved.)
3. Place a jack under the rear axle and elevate the axle just enough to take the tension off the lower shock absorber mount.
4. Remove the lower shock absorber bolt.
5. In the spare tire well, locate and remove the rubber plug which covers the access hole to the upper shock mount.

****CAUTION**

Remember the car is on jackstands. Do not climb into the trunk or the car may become unbalanced and fall off the stands. Work from the side of the car and reach into the trunk.

6. Remove the upper bolt and remove the shock absorber.

To install:

7. First tighten the upper bolt and then the lower one. Tighten both bolts to 63 ft. lbs. (85 Nm). Replace the rubber plug in the spare tire well.
8. Lower the rear axle and remove the jack.
9. Install the wheel and lower the vehicle. Tighten the wheel lugs to 63 ft. lbs. (85 Nm).

Trailing Arms

REMOVAL & INSTALLATION

In all cases (except Multi-link suspension), replacing the trailing arm requires removal of the axle assembly. Please refer to the rempval and installation procedure for the axle housing in Section 7. When the axle assembly is removed, the trailing arm is simply unbolted and removed. Check the arm carefully for any deformation or rusting. Also check all the bushings for any sign of wear or elongation.

Sway Bar

The sway bar, variously called the anti-roll bar or stabilizer bar, serves to control the sideways roll of the body during cornering. While the bar itself rarely fails, the links and bushings around it are prone to wear. If the bar is not rigidly mounted to the car, it cannot do its job properly.

REMOVAL & INSTALLATION

All 200 and 700 Series

➡This procedure applies only to those 200 and 700 series vehicles equipped with Volvo sway bars.

➧ See Figure 27

1. Safely jack and support the rear of the vehicle. Place the stands at the rear jacking points. While not absolutely necessary, the job may be easier if the wheels are removed.
2. Use a floor jack to raise the rear axle just enough to unload the lower shock absorber mount. Remove the lower shock retaining bolt.
3. Remove the nut holding the sway bar to the bracket.
4. On the other side of the car, remove the shock retaining bolt and the nut holding the sway bar to the bracket.

To install:

5. Install both the bracket nut and the lower shock retaining bolt hand-tight on one side. Then install the nut and bolt hand-tight on the other side.
6. Once all four mounting points are snug, tighten the bracket nuts to 35 ft.lbs and the shock absorber bolts to 63 ft. lbs. (85 Nm).
7. Remove the jack from the axle. Install the wheels if removed and lower the car to the ground. Tighten the wheel lugs for the 200 series to 85-90 ft. lbs. (115-122 Nm), or for the 700 series, tighten them to 63 ft. lbs. (85 Nm).

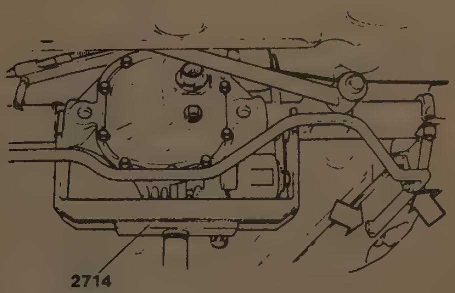

Fig. 27 The rear sway bar mounting bolts are indicated by the arrows — note the use of the Volvo rear axle cradle shown in this drawing

Multi-link Rear Suspension

1988-89 760 and 780

◆ **See Figure 28**

➡Multi-link suspensions require alignment any time the suspension components are disassembled. Position of components is critical as are torque values when retightening bolts.

Component Removal & Installation

SPRING, SHOCK ABSORBER AND SUPPORT ARM

◆ **See Figure 29**

➡It is important that the car be parked in a straight-ahead position with no side loadings in the suspension. After the car is in the work area, roll it forward and backwards 6-8 ft. (1.8-2.5 meters) and make sure the front and rear wheels point straight.

1. Safely elevate and support both ends of the car. Make sure the front supports are placed as far forward as possible. Check that the rear supports will not interfere with the support arm.
2. Remove the wheels. Loosen and remove the bolts holding the protective cover (guard) to the arm and remove the guard.
3. At the front of the arm, remove the two retaining bolts which hold the bracket (for the support arm) to the frame. Don't attempt to remove the through bolt (eye bolt).
4. Remove the retaining bolt at the rear of the support arm.
5. Separate the rear end of the support arm from the wheel bearing housing.
6. Using either Volvo tool 5972 or two floor jacks, support the arm at the front and rear ends. Elevate the jacks just enough to relieve the tension on the shock absorber.
7. Remove the retaining bolt at the top of the shock abosorber.
8. Lower the jacks slowly; the arm will come free with the spring and shock attached.
9. Remove the spring and the upper and lower rubber seats. Unbolt the shock absorber from the arm. If the support arm is to be replaced, unbolt and remove the bracket at the front of the arm. Take note of the relationship between the bracket and the arm; the bracket correctly mounts one way only.

To install:

10. Install the support arm bracket in the correct position and tighten the nut to 91 ft.lbs PLUS 120° of rotation.
11. Install the shock absorber on the arm and tighten the bottom mount to 41 ft. lbs. (55 Nm).
12. Install the bottom spring seat on the support arm. Take care to properly locate the grooves in the seat.
13. Install the spring and the top rubber seat. Place the assembled support arm on the jacks and raise into position.
14. Gently raise the jacks and compress the spring until the shock absorber is in the correct position. The shock may be

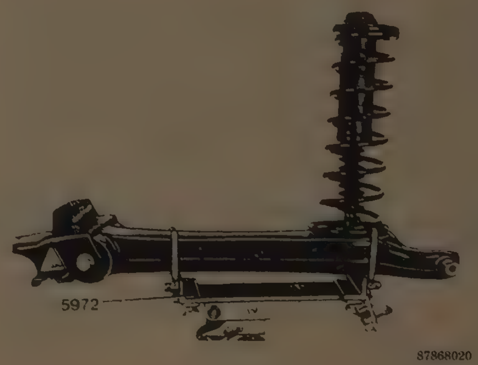

Fig. 29 Support the lower arm when working on vehicles equipped with Multi-link suspensions — Volvo special tool shown

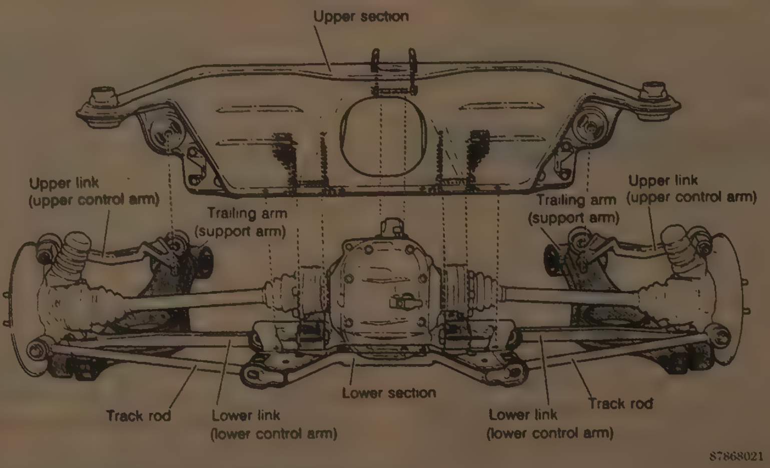

Fig. 28 The Volvo Multi-link suspension with components labeled

held in place temporarily with a drift in the hole. Insert the bolt and tighten it to 62 ft. lbs. (84 Nm).

15. Reinstall the mounting bolts at the front of the support arm bracket. Tighten the bolts to 35 ft. lbs. (47 Nm). and the large nut to 51 ft. lbs. (69 Nm).

16. At the rear of the support arm, tap the arm into place on the wheel bearing housing. Tighten the bolt to 44 ft. lbs. (60 Nm) PLUS 90° of rotation. Do not overtighten this fitting.

17. Reinstall the protective cover on the control arm. Install the wheel.

18. Lower the car to the ground and final tighten the lugs to 62 ft. lbs. (84 Nm).

19. Have the rear alignment checked and adjusted if necessary.

UPPER CONTROL ARM

****CAUTION**

The following procedure requires removal of the brakes. Brake pads and shoes may contain asbestos, which has been determined to a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling and dust from brake surfaces! When cleaning brakes, use commercially available brake cleaning fluids.

1. Safely elevate and support both ends of the car. Make sure the front supports are placed as far forward as possible. Check that the rear supports will not interfere with the support arm.
2. Remove the wheels. Remove the brake caliper and tie it with wire out of the way. Do not allow it to hang by its hose.
3. Remove the bolt holding the lower support arm to the wheel bearing housing and tap the support arm loose.
4. Remove the nut and bolt holding the lower control arm (intermediate arm) to the wheel bearing housing.
5. Remove the bolt attaching the track rod to the wheel bearing housing. Use a small bearing puller and a long 12mm bolt to disconnect the track rod.
6. Remove the nut which holds the upper control arm to the wheel bearing housing. Collect and note the location of the spacers between the upper control arm and the bearing housing. They are alignment shims and must be reinstalled properly.
7. At the rear of the upper control arm, remove the nut holding it to the rear axle member (support).
8. At the front of the upper control arm, remove the nut and bolt which holds it to the rear axle member.
9. Use a pair of adjustable pliers to remove the control arm from the car.

To install:

10. Install the new arm and install the nuts and bolts holding it to the rear axle member. Install both the front and rear mounts.
11. Install the spacers at the wheel bearing housing, position the arm and install the nut holding the arm to the housing.
12. Inboard, (at the rear axle support) tighten the rearmost nut to 62 ft. lbs. (84 Nm). Tighten the front nut and bolt to 51 ft. lbs. (69 Nm) PLUS 60° of rotation.
13. Pull the top of the wheel bearing housing outwards (away from the center of the car). This is essential for correct wheel alignment.
14. Tighten the upper control arm nut (at the bearing housing) to 84 ft. lbs. (114 Nm).
15. Pull the wheel bearing housing outward and install the lower control arm with its bolt and nut, but do not tighten it.
16. Pull the wheel bearing housing inwards (towards the center of the car). This is essential for correct wheel alignment.
17. Tighten the control arm nut to 37 ft. lbs. (50 Nm) PLUS 90° of rotation.
18. Reinstall the support arm; tighten its mount to 44 ft. lbs. (60 Nm) PLUS 90° of rotation.
19. Install the track rod and tighten to 62 ft. lbs. (84 Nm).
20. Install the brake caliper, tightening its mounting bolts to 44 ft. lbs. (60 Nm).
21. Install the wheel. Lower the car to the ground and tighten the wheel lugs to 62 ft. lbs. (84 Nm).
22. Have the rear alignment checked and adjusted if necessary.

Rear Wheel Alignment

The tracking of the rear wheels is as important as the tracking of the front. Any misalignment at the rear will give the car a loose or "slippery" feel under cornering. All the handling and tire wear conditions discussed under front end alignment apply equally to the rear; at the rear they are often harder to diagnose and cure.

On all but the Multi-link rear suspensions, the position of the rear wheels is fixed in all three dimensions by the correct location of the components. Any tire or handling problems not traced to other causes will require replacement of suspension parts. The alignment dimensions — caster, camber and toe — can be measured on an alignment rack but are not adjustable.

It should be noted that any time the rear wheel alignment is checked, the front must also be checked and set. Ideally this is done on a four wheel alignment machine which will provide data on the comparative front and rear track as well as each front and each rear wheel.

Simultaneous four wheel alignment capability is REQUIRED for cars with Multi-link rear suspension. Failure to use the proper equipment may result in the rear wheels having a mind of their own and steering in other directions than the driver might like. This "rear steer" effect can feel like roller skating on an ice rink; find an alignment shop with the proper equipment and get it done right. Volvo dealers are required by the manufacturer to have the proper equipment.

The Multi-link suspension is adjusted for camber and toe through the use of eccentric bolts in the suspension links. The camber adjuster is located on the inboard end of the lower link. The toe adjuster is located at the inboard end of the track rod. Neither should be adjusted by anyone who is not using a four wheel alignment machine and the specifications book.

An additional adjustment controls toe variation. Although the toe setting can be numerically correct with the car at rest, it can change as a function of load and suspension motion. This very minor change can greatly upset the handling of the car. By inserting precisely sized shims between the upper control arm and the wheel bearing housing, this minor variation can be further controlled. This is particularly handy if the car constantly has a load in the trunk or constantly carries several people. The rear suspension can be fine-tuned for the best road manners under given load conditions.

STEERING

Steering Wheel

REMOVAL & INSTALLATION

➡The use of a knock-off type steering wheel puller or the use of a hammer may damage the collapsible column.

1970-71 140 Series and 164 Models

1. Disconnect the negative battery cable.
2. Remove the retaining screw from the upper half of the molded turn signal switch housing and the three retaining screws from the lower half. Remove both halves from the column.
3. Remove the two screws which retain the horn ring to the steering wheel. Turn and lift up the horn ring and disconnect the plug contact.
4. Remove the steering wheel nut.
5. With the front wheels pointing straight ahead, and the steering wheel centered, install the steering wheel puller (Volvo tool 2711 or similar) and pull off the steering wheel.

To install:

6. Make sure that the front wheels are pointing straight ahead, then place the centered steering wheel on the column and install the nut. Tighten the steering wheel nut to 25-30 ft. lbs. (34-41 Nm).
7. Connect the horn plug contact and install the horn ring.
8. First install the lower and then the upper turn signal housing halves and their retaining screws.
9. Connect the negative battery cable and check the operation of the horn.

1972 140 Series and 164 Models

1. Disconnect the negative battery cable.
2. Remove the retaining screw for the upper half of the molded turn signal switch housing and lift off the housing.
3. Pry up and remove the impact protection from the horn ring. Disconnect the plug contact for the horn and remove the four retaining screws for the horn ring. Lift off the horn ring, noting the positions of the various springs and washers.
4. Remove the steering wheel nut.
5. With the front wheels pointing straight ahead, and the steering wheel centered, install a steering wheel puller (Volvo tool 2972 or similar) and pull off the steering wheel.
6. Remove the turn signal switch flange.

To install:

7. Make sure that the front wheels are pointing straight ahead, then position the turn signal switch flange into the column and place the centered steering wheel on the column. Install the steering wheel nut and tighten to 20-30 ft. lbs. (27-41 Nm).
8. Making sure the springs and washers are positioned correctly, install the horn ring on the steering wheel and tighten the four retaining screws. Connect the horn`plug contact.
9. Install the upper turn signal housing half.
10. Connect the negative battery cable and test the operation of the horn.

1800 Series

1. Disconnect the negative battery cable.
2. Pry off the steering wheel impact pad.
3. Disconnect the horn plug contact. Remove the three retaining screws and lift off the horn ring, (if so equipped) noting the placement of the springs and washers.
4. Bend back the lockring washer and remove the steering wheel nut. Mark the relative positions of the steering wheel to the column. Loosen the horn wire.
5. Install the steering wheel puller and pull off the wheel.

To install:

6. Place the steering wheel on the column so that the alignment marks made prior to removal line up. Install the nut and tighten to 20-30 ft. lbs. (27-41 Nm).
7. Connect the horn plug contact, and install the horn ring, springs, and washers with the three retaining screws (if so equipped).
8. Snap on the impact pad.
9. Connect the negative cable and test the operation of the horn.

1973 and Later 100 and 200 Series

➧ See Figures 30, 31, 32, 33 and 34

1. Disconnect the negative battery cable.
2. Remove the retaining screws for the upper half of the molded turn signal housing and lift off the housing.
3. Pry off the steering wheel impact pad.
4. Disconnect the horn plug contact.

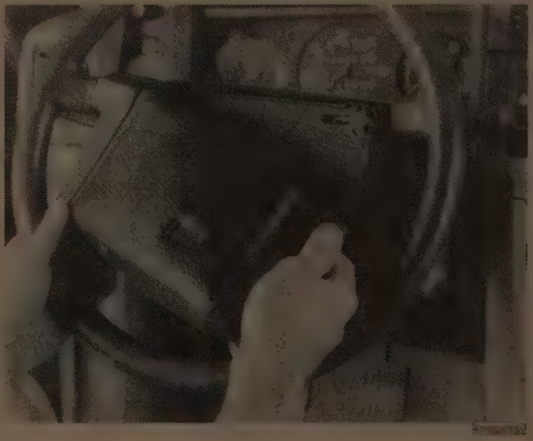

Fig. 30 Remove the steering wheel impact pad and set it aside

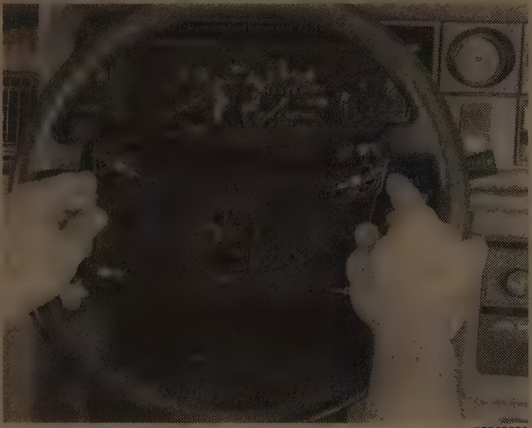

Fig. 31 Pull away the plate that serves as the horn plug contact

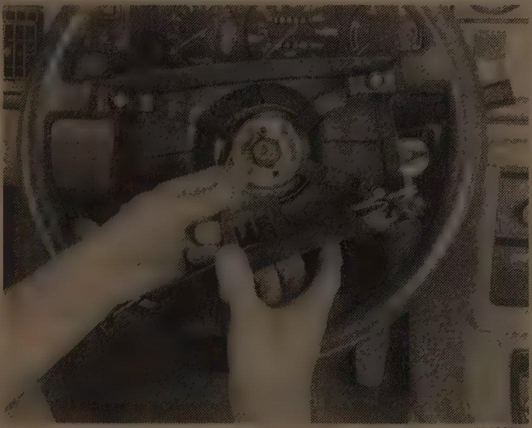

Fig. 32 Disconnect the horn plug contact taking care not to damage the connector or wire

5. Remove the steering wheel nut.

➡Due to a change in the cone angle of this steering shaft, a puller is not needed on 1979 and later models. Mark the steering wheel alignment to facilitate correct installation.

6. With the front wheels pointing straight ahead and the steering wheel centered, install a steering wheel puller. On 164 models, use an outside circumference type (Volvo No. 5003 or similar) and pull off the steering wheel. On 140, 240, and 260 models, use a universal type puller (Volvo No. 2263 or similar).

To install:

7. Make sure that the front wheels are pointing straight ahead and place the centered steering wheel on the column. Keep the plug contact on the left side and install the nut. Tighten it to 20-30 ft. lbs. (27-41 Nm).

8. Connect the horn plug contact and install the impact pad.

9. Install the upper turn signal housing half.

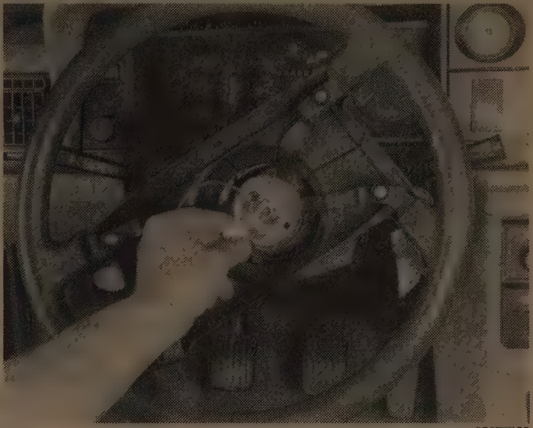

Fig. 33 Mark the position of the steering wheel to aid alignment when installing

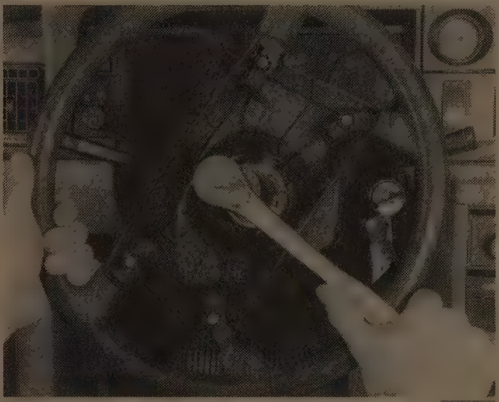

Fig. 34 Use the correct metric socket to remove the steering wheel nut — 1979 and later models need not use a steering wheel puller

10. Connect the negative battery cable and test the operation of the horn.

700 Series Without Supplemental Restraint System (SRS)

1. Disconnect the negative battery cable.
2. Gently pry up the lower edge of the steering wheel center pad and remove it.
3. Unscrew the steering wheel center nut and remove the steering wheel.
4. When installing the steering wheel, torque the center to 26 ft. lbs. (35 Nm).
5. Install the center pad and snap it into place. Reconnect the negative battery cable.

760 and 780 With Supplemental Restraint System

➧ See Figures 35, 36, 37 and 38

Some 1987-88 and 1989 Volvo 780 and 760 series include an electrically operated Supplemental Restraint System (SRS) or airbag system. The SRS system can deploy during electrical testing or other work if certain steps are not followed. While the airbag and inflator are in the steering column, the system has various other wires and components located under the dash and under the seat.

If your car is equipped with SRS, observe the following rules when performing any work in or around the steering column or dashboard:

- If you are not absolutely sure of the identity of a component, leave it alone.
- Know where a wire goes before applying voltage or checking resistance.
- Turn the ignition to **OFF** and disconnect the negative battery cable before disconnecting any electrical connectors inside the car.
- Be sure that the integrity of the SRS wiring is not disturbed during the installation of accessories such as CB radios, phones, audio equipment, etc.
- If the steering wheel must be removed, the bag assembly must first be removed and disconnected from the center of the wheel. Put the unit to the side and DO NOT attempt to check resistance at the inflator.
- On 780 series, ALWAYS disconnect the 4-pin yellow connector at the lower part of the steering column near the center console. The front seat belts are also part of the SRS system. If any diagnostics must be done to the seat belt system, disconnect the seat belt tensioners (grey connectors under the driver's seat) before doing any work.
- On the 760 series, ALWAYS disconnect the 4-pin yellow connector.
- Do not disconnect the main lead to the sensor box under the seat.
- Volvo specifically recommends against anyone other than factory-trained personnel attempting repairs or diagnosis on the SRS system.

To remove the steering wheel:

1. Park the car with the front wheels and the steering wheel straight.
2. Switch off the ignition and disconnect the negative battery cable. Disconnect the yellow connector in the SRS harness.

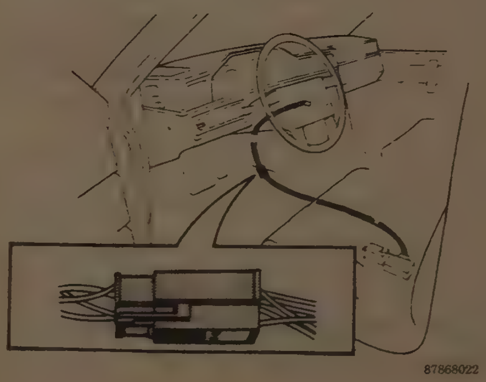

Fig. 35 Always unplug the yellow connector before performing any electrical diagnostic work — 1988 760 with SRS shown

3. Remove the 3mm Allen screw holding the steering wheel adjuster.
4. Remove the five screws in the lower cover and remove the covers.
5. Remove the two Torx® screws (size: T-27) from the back side of the steering wheel. This will free the airbag assembly in the center pad of the wheel. Disconnect the wire at the bag unit and set it aside.
6. Remove the bolt in the center of the steering wheel but leave the wheel in place.
7. Remove the lock screw (at the end of the plastic label) from its storage position in the wheel hub. Install the lock screw through the steering wheel hub to lock the contact reel. Do not turn the wheel after the lock screw is in place; the pin in the contact reel will shear.
8. Lift off the steering wheel.

To install:

9. Feed the wire through the steering wheel and place the wheel in position. Make sure the pin on the contact reel aligns with the center of the hole in the steering wheel.
10. Install the center bolt for the steering wheel and tighten finger tight only.
11. Remove the lock screw from the contact reel. Rewind the flag and store it in its compartment.
12. Tighten the steering wheel center nut to 24 ft. lbs. (32 Nm).
13. Place the lower part of the airbag assembly on the steering wheel (1). Connect the electrical connector and insure that it clicks into position (2). Align the bag assembly and rotate it up into place (3). Install the two Torx® screws through the back of the wheel and tighten them to 6 ft. lbs. (8 Nm).
14. Make sure that the steering wheel can be turned freely and that the column ignition lock functions correctly.
15. Reinstall the steering wheel covers and the wheel adjustor handle. Connect the yellow connectors in the SRS system. Connect the negative battery cable.

Combination Switch (Windshield Wiper Switch/Turn Signal Switch)

REMOVAL & INSTALLATION

➧ **See Figure 39**

****CAUTION**

This procedure requires removal of the steering wheel. If the vehicle is equipped with the SRS (airbag) system, refer to the safety precautions listed earlier in this section. DO NOT remove the wheel until these precautions have been followed.

1. Turn the steering wheel to the straight ahead position.
2. Remove the center pad from the wheel.
3. Remove the steering wheel retaining bolt. If possible, matchmark the wheel and steering shaft. If the vehicle is equipped with SRS, pull out the locking screw and the long tape label from its station in the steering wheel hub. Use the lock screw (with the tape flag attached) to lock the contact reel

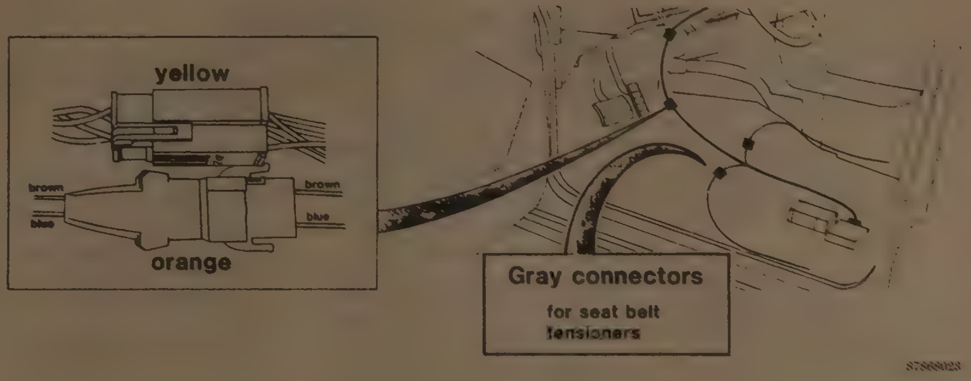

Fig. 36 Location of SRS connectors — 1987 780 shown

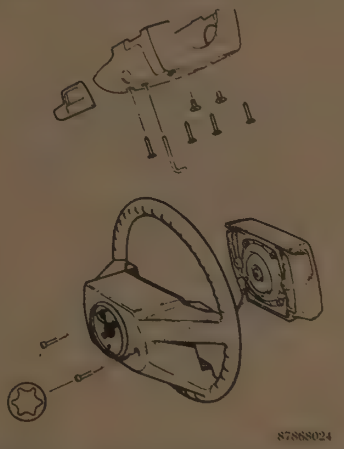

Fig. 37 Location of various retaining bolts — SRS-equipped vehicles

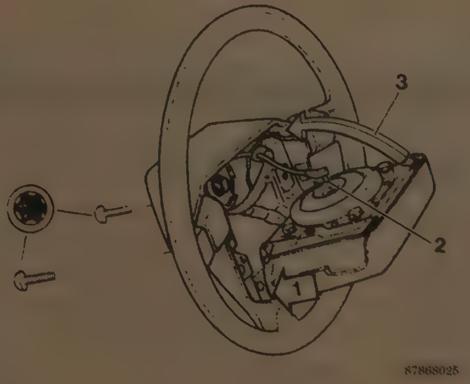

Fig. 38 Reinstall the airbag unit in the three sequential steps shown

through the hole in the steering wheel hub. Do not turn the steering wheel once the bolt is removed; the pin in the contact reel will shear.

4. Remove the steering wheel and the upper and lower steering column casings.
5. To remove the wiper switch, simply remove the screws holding it to the column and unplug the connector. The turn signal switch is on the opposite side and is also held to the column by two or three screws.

To install:

6. Check the position of all the wires so that nothing is pinched in the casings.
7. Reinstall the column casings and then reinstall the steering wheel. Check that the steering wheel position is true to the position of the wheels. If the vehicle is SRS equipped, do not turn the steering wheel until the center bolt is reinstalled and tight; doing so will shear the pin in the contact reel. Remove the locking bolt with its flag and store it in the extra hole on the left side of the wheel.
8. Tighten the steering wheel bolt to 24 ft. lbs. (32 Nm).Reinstall the center pad.
9. If equipped with the SRS system, make the necessary connections to reactivate the system.

Ignition Switch

REMOVAL & INSTALLATION

➧ See Figure 40

On all models, the ignition keylock is mounted on the steering column and incorporates a steering wheel lock to deter car theft. The lock is attached to the steering column by shearbolts, whose heads break off when the proper tightness is reached. Removing the lock requires removing these bolts, either by cutting slots in their tops and using a screwdriver to extract them, or by drilling them out.

If they are drilled out, the lock housing will probably be damaged. On many models, removing the ignition lock also requires loosening or removing the steering column. Because

Troubleshooting the Turn Signal Switch

Problem	Cause	Solution
Turn signal will not cancel	• Loose switch mounting screws • Switch or anchor bosses broken • Broken, missing or out of position detent, or cancelling spring	• Tighten screws • Replace switch • Reposition springs or replace switch as required
Turn signal difficult to operate	• Turn signal lever loose • Switch yoke broken or distorted • Loose or misplaced springs • Foreign parts and/or materials in switch • Switch mounted loosely	• Tighten mounting screws • Replace switch • Reposition springs or replace switch • Remove foreign parts and/or material • Tighten mounting screws
Turn signal will not indicate lane change	• Broken lane change pressure pad or spring hanger • Broken, missing or misplaced lane change spring • Jammed wires	• Replace switch • Replace or reposition as required • Loosen mounting screws, reposition wires and retighten screws
Turn signal will not stay in turn position	• Foreign material or loose parts impeding movement of switch yoke • Defective switch	• Remove material and/or parts • Replace switch
Hazard switch cannot be pulled out	• Foreign material between hazard support cancelling leg and yoke	• Remove foreign material. No foreign material impeding function of hazard switch—replace turn signal switch.
No turn signal lights	• Inoperative turn signal flasher • Defective or blown fuse • Loose chassis to column harness connector • Disconnect column to chassis connector. Connect new switch to chassis and operate switch by hand. If vehicle lights now operate normally; signal switch is inoperative • If vehicle lights do not operate, check chassis wiring for opens, grounds, etc.	• Replace turn signal flasher • Replace fuse • Connect securely • Replace signal switch • Repair chassis wiring as required
Instrument panel turn indicator lights on but not flashing	• Burned out or damaged front or rear turn signal bulb • If vehicle lights do not operate, check light sockets for high resistance connections, the chassis wiring for opens, grounds, etc. • Inoperative flasher • Loose chassis to column harness connection • Inoperative turn signal switch • To determine if turn signal switch is defective, substitute new switch into circuit and operate switch by hand. If the vehicle's lights operate normally, signal switch is inoperative.	• Replace bulb • Repair chassis wiring as required • Replace flasher • Connect securely • Replace turn signal switch • Replace turn signal switch
Stop light not on when turn indicated	• Loose column to chassis connection • Disconnect column to chassis connector. Connect new switch into system without removing old.	• Connect securely • Replace signal switch

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Troubleshooting the Ignition Switch

Problem	Cause	Solution
Ignition switch electrically inoperative	• Loose or defective switch connector • Feed wire open (fusible link) • Defective ignition switch	• Tighten or replace connector • Repair or replace • Replace ignition switch
Engine will not crank	• Ignition switch not adjusted properly	• Adjust switch
Ignition switch wil not actuate mechanically	• Defective ignition switch • Defective lock sector • Defective remote rod	• Replace switch • Replace lock sector • Replace remote rod
Ignition switch cannot be adjusted correctly	• Remote rod deformed	• Repair, straighten or replace

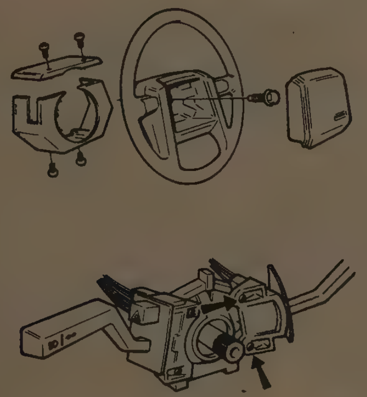


Fig. 39 Remove the steering wheel, then the wiper and turn signal switches — non-SRS-equipped 700 series components shown

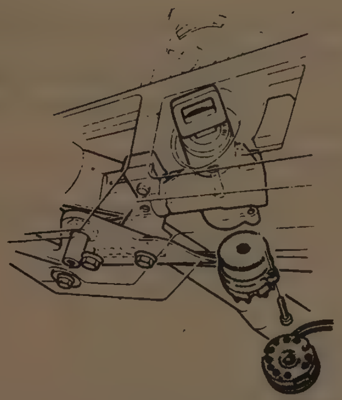


Fig. 40 Exploded view of the replaceable ignition switch components — mounted behind the ignition key — 700 series shown. Others are similar

of the complexity of these operations, repairs are best left to a professional repair facility.

If your diagnosis of an problem shows a failed ignition switch, the electrical part at the rear of the assembly can be changed on all 1975 and later models.

✻✻CAUTION

If the vehicle is equipped with the SRS (airbag) system, refer to the safety precautions listed earlier in this section.

Disconnect the negative battery cable and gain access to the back of the ignition switch by removing panels and covers as necessary. Remove the round multi-wire connector at the back of the switch, then unfasten and remove the electrical unit (sometimes called the start contact) from the back of the lock assembly.

This unit is generally held on with two small screws, but they are in a difficult location and an awkward position — have patience. When reassembling, make certain that the new unit is properly seated against the pin from the ignition lock. Also insure that the wiring connector is firmly attached to the new start contact.

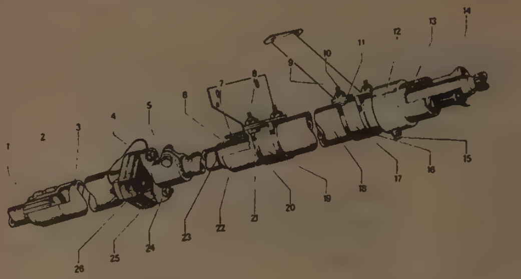
Steering Column Upper Shaft

REMOVAL & INSTALLATION

1800 Series

➧ See Figure 41

1. Disconnect the negative battery cable. Remove the clamping bolt at the base of the column.
2. Remove the steering wheel. Remove the flange, the turn signal switch, the spring and the bearing seat.
3. Disconnect the lock ring (circlip) and pull down the spring and lower bearing seat.
4. Pull the column out of the casing. Use the steering wheel to help you pull.



1. Steering cam
2. Nut
3. Sleeve
4. Ground wire.
5. Clamp bolt
6. Spring
7. Seat
8. Lower mount
9. Upper mount
10. Shear bolt
11. Spacer
12. Steering lock mount
13. Upper bearing
14. Flange
15. Bolt
16. Rubber bushing
17. Clamp
18. Steering column casing
19. Clamp
20. Rubber bushing
21. Bolt
22. Lower bearing
23. Lock ring
24. Nut
25. Flange
26. Rubber coupling disc.

Fig. 41 Details of the steering column (and legend) — 1800 series

To install:

5. Insert the column in the casing and make sure the parts of the lower bearing are in place.

6. Run the horn cable into position. Push the steering column into position in the flange (at the lower joint) and install the clamping bolt and lock ring.

7. At the upper end, replace the bearing seat and spring, the flange and the turn signal switch.

8. Reinstall the steering wheel and check the function of the steering column lock. Reconnect the battery cable and check the function of the turn signals.

100 Series

▸ See Figure 42

1. Disconnect the negative battery cable.

2. Remove the steering wheel. Remove the flange, the turn signal switch, the spring and the bearing seat.

3. Separate the sleeve (holding the upper and lower columns) located near the floor.

4. Pull the column free of the casing.

5. When assembling, insert the steering shaft and position it in the sleeve. Tighten the sleeve nut to 30 ft. lbs. (41 Nm), then bend the lock tab into one of the slots.

6. At the upper end, replace the bearing seat and spring, the flange and the turn signal switch.

7. Reinstall the steering wheel and check the function of the steering column lock. Reconnect the battery cable and check the function of the turn signals.

200 Series

▸ See Figures 43, 44, 45 and 46

1. Disconnect the negative battery cable.

2. Under the hood, remove the clamping bolt at the shaft joint.

3. Remove the steering wheel.

4. Remove the plastic column covers.

5. Disconnect the wiring and remove the turn signal and wiper controls.

6. Remove the housing which holds the switches. Remove the spring and race for the upper bearing.

7. Find the two bolts for the steering lock. They will not have heads on them. Drill holes exactly in the center of the bolts and use a screw extractor to remove the bolts.

8. Remove the rubber grommet for the steering shaft at the firewall.

9. Push the steering shaft in through the firewall until clear of the lower part of the dashboard. Pull the shaft back into the driver's compartment.

10. Disconnect the steering lock from the shaft. Either install it on the new shaft or install the new lock on the present shaft.

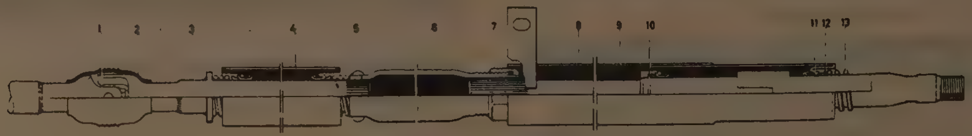
To install:

11. Install the rubber grommet onto the end of the shaft. Push the column into place and fit it through the firewall. Position the column so the steering lock projects through the hole in the panel.

12. Attach the joint to the shaft and tighten the nut and bolt.

13. Install new shear bolts, but DO NOT break them. Later adjustment may be required.

14. Install the rubber grommet in the firewall.



1. Universal joint
2. Rubber seal
3. Lower column section
4. Lower column casing
5. Rivet
6. Sleeve
7. Nut
8. Upper column section
9. Upper column casing
10. Ring
11. Bearing
12. Seat
13. Spring

Fig. 42 Details of the steering column (and legend) — 1800 series

Fig. 43 With the steering wheel removed, next unscrew the lower and the upper halves of the plastic steering column cover

Fig. 44 Set the covers aside, then disconnect the turn signal and wiper controls

15. At the upper end, install the switch bracket. Don't forget to connect the ground wire to one of the screws.
16. Install the turn signal switch, wiper switch and connect the wiring.
17. Install the race and spring for the upper bearing. Replace the plastic column covers.
18. Check that the front wheels point straight ahead and install the steering wheel. Tighten the nut to 25 ft. lbs. (34 Nm).
19. Turn the steering wheel and check for free rotation and no binding or rubbing. Make any needed adjustments before continuing.
20. Tighten the lower attachment bolts and then tighten the shear bolts. Keep turning the bolts until the heads break off.
21. Reconnect the battery cable and check the operation of the horn, turn signals and wipers.

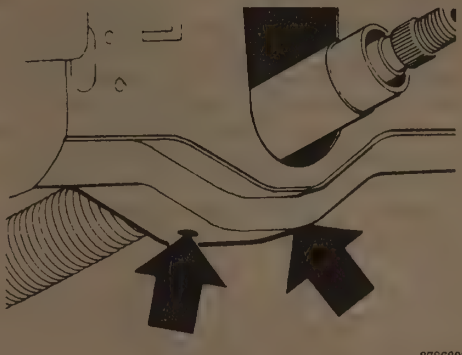


Fig. 45 Location of the shear-head bolts — 200 series

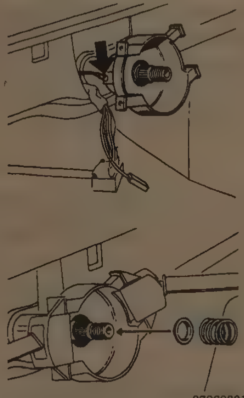


Fig. 46 Remember to attach the ground wire (upper drawing) and install the bearing race (lower drawing) correctly — 200 series

700 Series

➧ See Figure 47

✻✻CAUTION

If the vehicle is equipped with the SRS (airbag) system, refer to the safety precautions listed earlier in this section.

1. Disconnect the negative battery cable.
2. Under the hood, disconnect the upper steering shaft clamp bolt and snap ring. Then disconnect the lower steering shaft clamp bolt and snapring.
3. Push the steering shaft towards the firewall to free it from the clamp joint.

✻✻WARNING

On SRS equipped vehicles, refer to the specific removal procedures listed under "Steering Wheel, Removal and Installation" in this section.

4. Remove the steering wheel and remove the upper and lower plastic covers around the steering column.
5. Remove the horn wire, disconnect the wiring to the wiper and turn signal switches and remove the switches.
6. Remove the panel under the column and remove the heater hose. Remove the panel around the ignition switch and the heater controls. Be careful not to scratch the trim.
7. Find the two bolts for the steering lock. They will not have heads on them. Drill holes exactly in the center of the bolts and use a screw extractor to remove the bolts.
8. Remove the single bolt in the support bar.
9. At the floorboard, remove the three screws for the lower bearing plate
10. Under the dash, loosen (but do not remove) the three bolts for the steering column support bracket. One bolt is located high, about behind the speedometer; the other two are on the extreme left side of the dash.
11. Insert the key and turn it to position **ON**. Remove the retaining screw. Press in the locking tab and withdraw the lock assembly. Remove the key and disconnect the wiring from the switch.
12. Carefully pull down on the support bracket and lift out the steering column guide. Remove the steering column.
13. Check the length of the steering column. The collapsible coupling must be intact. Correct overall length of the shaft is 28.59-28.67 in. (726-728mm). If the shaft isn't the correct length, replace it.

To install:

14. Place the shaft within the guide and insert into place in the dash. If the shaft was disassembled or replaced, remember to fit the triangular bearing plate onto the bottom of the shaft.
15. Install new shear bolts. Snug them to hold but DO NOT break them yet. Install the single bolt into the bottom of the support bracket.
16. Insert the key in the ignition lock and turn it to II. Press the lock tab down and place the lock in position. Make sure that it bottoms correctly in its housing. Tighten the retaining screw and check the operation of the key and column lock assembly.
17. Tighten the bolts for the steering column support.

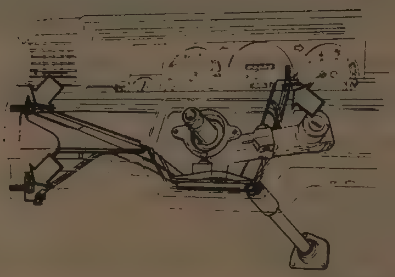


Fig. 47 Loosen (but do not remove) the three bolts for the steering column support bracket

18. Install the lower bearing plate at the floorboard.
19. Double check placement of the column in the dash. Make any necessary adjustments in position. Make sure no wiring or cables are snagged or pulled out of place.
20. Tighten the two shear bolts until the heads break off.
21. Install the wiper and turn signal switches. Connect the switch wiring and connect the horn wiring.
22. Install the upper and lower steering column cover.
23. Replace the trim panel for the ignition switch and the heater controls. Install the heater hose and reinstall the lower panel.
24. Under the hood, attach the upper joint to the upper steering shaft. Tighten the bolt to 15 ft. lbs. (20 Nm). Tighten the lower joint to the same value. Install the snaprings.

****WARNING**

On SRS equipped vehicles, refer to the specific installation procedures listed under "Steering Wheel, Removal and Installation" in this section.

25. Install the steering wheel and tighten the center nut to 25 ft. lbs. (34 Nm). Install the center pad.
26. If the vehicle is SRS equipped, reconnect the harness connectors. Attach and secure the negative battery cable.

Steering Linkage

REMOVAL & INSTALLATION

140 Series, 164 Models and 1800 Series

➧ **See Figure 48**

Bent or damaged steering rods and tie rods must be replaced, never straightened. All components of the steering linkage, including the Pitman arm and idler arm (on worm and roller steering types), are connected by means of ball joints. Ball joints cannot be disassembled or adjusted, so they must also be replaced when damaged. They should also be replaced if the rubber seal is broken and the joint contaminated.

The ball joints of the steering rods are made in unit with the rods, therefore the entire rod assembly must be replaced when the ball joint becomes unserviceable. Maximum permissible axial (vertical) play is 0.120 in. (3mm). After removing the cotter pins and ball stud nuts, use a ball joint separator and press the balljoint out of its connecting socket.

The ball joints on the tie rod may be replaced individually. After the ball joint is disconnected, the locknut on the tie rod is loosened and the clamp bolt released. The ball joint is then screwed out of the tie rod, taking note of the number of turns. The new ball joint is screwed in exactly the same number of turns, and the clamp bolt and locknut tightened.

After reconditioning the rods and joints, the wheel alignment must be adjusted.

The Pitman arm, relay arm (idler arm) and various other steering links are removed in straightforward manner. Remove the cotter pin and locknut from the appropriate ball joints and separate the joints. In the case of the Pitman arm arm, bend up the lock tab at the nut and remove the nut. The arm may

Troubleshooting the Steering Column

Problem	Cause	Solution
Will not lock	• Lockbolt spring broken or defective	• Replace lock bolt spring
High effort (required to turn ignition key and lock cylinder)	• Lock cylinder defective	• Replace lock cylinder
	• Ignition switch defective	• Replace ignition switch
	• Rack preload spring broken or deformed	• Replace preload spring
	• Burr on lock sector, lock rack, housing, support or remote rod coupling	• Remove burr
	• Bent sector shaft	• Replace shaft
	• Defective lock rack	• Replace lock rack
	• Remote rod bent, deformed	• Replace rod
	• Ignition switch mounting bracket bent	• Straighten or replace
	• Distorted coupling slot in lock rack (tilt column)	• Replace lock rack
Will stick in "start"	• Remote rod deformed	• Straighten or replace
	• Ignition switch mounting bracket bent	• Straighten or replace
Key cannot be removed in "off-lock"	• Ignition switch is not adjusted correctly	• Adjust switch
	• Defective lock cylinder	• Replace lock cylinder
Lock cylinder can be removed without depressing retainer	• Lock cylinder with defective retainer	• Replace lock cylinder
	• Burr over retainer slot in housing cover or on cylinder retainer	• Remove burr
High effort on lock cylinder between "off" and "off-lock"	• Distorted lock rack	• Replace lock rack
	• Burr on tang of shift gate (automatic column)	• Remove burr
	• Gearshift linkage not adjusted	• Adjust linkage
Noise in column	• One click when in "off-lock" position and the steering wheel is moved (all except automatic column)	• Normal—lock bolt is seating
	• Coupling bolts not tightened	• Tighten pinch bolts

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need gentle tapping to come free of the splines on the steering box. Keep the following general rules in mind:

1. Always use the correct tool to separate ball joints. Improper tools will damage the joint or rip the boot.
2. Keep the mating surfaces of rods and joints clean.
3. If the relay rod was removed, tighten its mounting nut to 55 ft. lbs. (75 Nm).
4. Do not disturb the position of the front wheels when any component is disconnected.
5. Always have the alignment checked and adjusted after any steering repair.

All 200 and 700 Series

These models are equipped with rack and pinion steering (manual or power). Rack and pinion systems save space and weight, improve steering response and eliminate most of the rods and linkage under the car.

Two different units are used, either ZF manual or power steering or CAM manual or power steering. On all types, the tie rod ends are removed by disconnecting the ball joint at the steering knuckle, loosening the locknut and unscrewing the tie rod end from the tie rod. Count every full turn needed to remove the tie rod end from the tie rod and install the new tie rod end that exact number of turns. Tighten the locknut and attach the ball joint at the steering knuckle. Have the alignment checked and reset if necessary. If close attention was paid to the exact number of turns of each tie rod end, the alignment should not be far off specification.

When servicing the tie rods, check the rubber bellows for cracks or leaks. The bellows can be replaced by removing the tie rod end, loosening the clamps and pulling the bellows off the tie rod. On both manual and power steering CAM gear boxes, the rack is filled with gear oil. On both manual and power steering ZF gear boxes, the rack is packed with special fluid grease.

Troubleshooting the Steering Column (cont.)

Problem	Cause	Solution
Noise in column (cont.)	• Lack of grease on bearings or bearing surfaces • Upper shaft bearing worn or broken • Lower shaft bearing worn or broken • Column not correctly aligned • Coupling pulled apart • Broken coupling lower joint • Steering shaft snap ring not seated • Shroud loose on shift bowl. Housing loose on jacket—will be noticed with ignition in "off-lock" and when torque is applied to steering wheel.	• Lubricate with chassis grease • Replace bearing assembly • Replace bearing. Check shaft and replace if scored. • Align column • Replace coupling • Repair or replace joint and align column • Replace ring. Check for proper seating in groove. • Position shroud over lugs on shift bowl. Tighten mounting screws.
High steering shaft effort	• Column misaligned • Defective upper or lower bearing • Tight steering shaft universal joint • Flash on I.D. of shift tube at plastic joint (tilt column only) • Upper or lower bearing seized	• Align column • Replace as required • Repair or replace • Replace shift tube • Replace bearings
Lash in mounted column assembly	• Column mounting bracket bolts loose • Broken weld nuts on column jacket • Column capsule bracket sheared • Column bracket to column jacket mounting bolts loose • Loose lock shoes in housing (tilt column only) • Loose pivot pins (tilt column only) • Loose lock shoe pin (tilt column only) • Loose support screws (tilt column only)	• Tighten bolts • Replace column jacket • Replace bracket assembly • Tighten to specified torque • Replace shoes • Replace pivot pins and support • Replace pin and housing • Tighten screws
Housing loose (tilt column only)	• Excessive clearance between holes in support or housing and pivot pin diameters • Housing support-screws loose	• Replace pivot pins and support • Tighten screws
Steering wheel loose—every other tilt position (tilt column only)	• Loose fit between lock shoe and lock shoe pivot pin	• Replace lock shoes and pivot pin
Steering column not locking in any tilt position (tilt column only)	• Lock shoe seized on pivot pin • Lock shoe grooves have burrs or are filled with foreign material • Lock shoe springs weak or broken	• Replace lock shoes and pin • Clean or replace lock shoes • Replace springs
Noise when tilting column (tilt column only)	• Upper tilt bumpers worn • Tilt spring rubbing in housing	• Replace tilt bumper • Lubricate with chassis grease
One click when in "off-lock" position and the steering wheel is moved	• Seating of lock bolt	• None. Click is normal characteristic sound produced by lock bolt as it seats.
High shift effort (automatic and tilt column only)	• Column not correctly aligned • Lower bearing not aligned correctly • Lack of grease on seal or lower bearing areas	• Align column • Assemble correctly • Lubricate with chassis grease
Improper transmission shifting—automatic and tilt column only	• Sheared shift tube joint • Improper transmission gearshift linkage adjustment • Loose lower shift lever	• Replace shift tube • Adjust linkage • Replace shift tube

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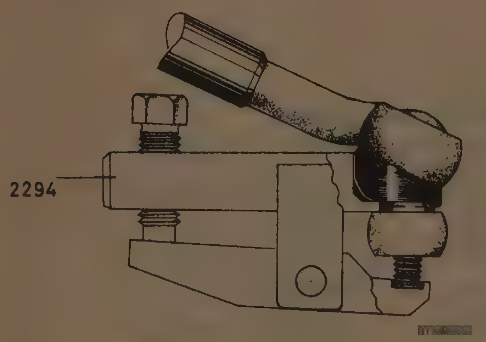


Fig. 48 Use a proper ball joint separator such as this Volvo tool, No. 2294, shown installed and ready to press out the ball joint

Manual Steering Gear

➧ See Figure 49

REMOVAL & INSTALLATION

140 and 1800 Series; 164 Models

1. Jack up the front end of the vehicle and support on jackstands.
2. Release the bolt at the lower steering coupling flange. Remove the nuts and push the lower part of the flange as far down as possible on the guide bolt.
3. Remove the locknut for the Pitman arm. Matchmark the arm and the shaft for ease of reassembly. Pull off the Pitman arm with a Pitman arm puller (Volvo tool 2370 or equivalent). When the puller has been set in place, turn the wheels completely to the left.
4. Remove the nuts and bolts and lift off the steering gearbox.

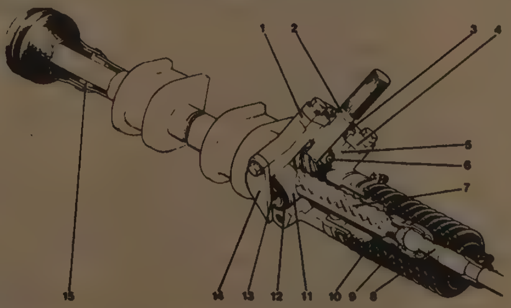
To install:

5. Make sure the steering gearbox is in its centered position. (Alternate position is full left.) Reinstall the steering gear in position and secure the mounting bolts.
6. Set the wheels so they match the setting of the steering gearbox, i.e. centered or full left, and place the steering wheel in the same position. Secure both halves of the lower flange. Check that the flange splines coincide with the shaft splines.
7. Install the Pitman arm to the steering gearbox. If the steering gear and Pitman arm are matchmarked, make sure the marks align and reinstall the arm. If the gear and arm are not marked, follow the procedure below:
   a. Turn the steering wheel fully to the left.
   b. Turn the steering wheel fully to the right (until it binds) and count the number of turns the wheel makes from left lock to right lock. Measure the turns carefully and approximate any fractional turns (1/2,1/4, etc).
   c. Beginning at right lock, return the wheel one half of the number of turns it took to get there. This will put the steering gear box at its centered position.
   d. Set the left wheel straight ahead.
   e. Connect the Pitman arm to the steering box.
   f. Lower the car to the ground and check that the wheels are straight ahead. If it is necessary to adjust the wheels, remember to use the correct tool when removing the Pitman arm from the shaft.
8. Tighten the Pitman arm bolt to 110 ft. lbs. (149 Nm).
9. Lower the car to the ground and road test for proper steering alignment.

200 Series

➧ See Figure 50

1. Remove the lock bolt and nut from the column flange. Bend apart the flange slightly with a prybar.
2. Jack up the front end. The stands should be positioned at the jack supports. Remove the front wheels.
3. Disconnect the tie rod ends, using a ball joint puller.
4. Remove the splash guard.
5. Disconnect the steering gear from the front axle member (beam).



1. Housing
2. Pinion
3. Seal
4. Pinion cover
5. Spacer sleeve
6. Upper Pinion bearing
7. Rack
8. Steering rod
9. Inner ball joint
10. Rubber bellow
11. Pre-tensioning piston
12. O-ring
13. Spring
14. Cover
15. Bushing

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Fig. 49 Cutaway view of Volvo's manual rack and pinion steering gear

Troubleshooting the Manual Steering Gear

Problem	Cause	Solution
Hard or erratic steering	• Incorrect tire pressure	• Inflate tires to recommended pressures
	• Insufficient or incorrect lubrication	• Lubricate as required (refer to Maintenance Section)
	• Suspension, or steering linkage parts damaged or misaligned	• Repair or replace parts as necessary
	• Improper front wheel alignment	• Adjust incorrect wheel alignment angles
	• Incorrect steering gear adjustment	• Adjust steering gear
	• Sagging springs	• Replace springs
Play or looseness in steering	• Steering wheel loose	• Inspect shaft spines and repair as necessary. Tighten attaching nut and stake in place.
	• Steering linkage or attaching parts loose or worn	• Tighten, adjust, or replace faulty components
	• Pitman arm loose	• Inspect shaft splines and repair as necessary. Tighten attaching nut and stake in place
	• Steering gear attaching bolts loose	• Tighten bolts
	• Loose or worn wheel bearings	• Adjust or replace bearings
	• Steering gear adjustment incorrect or parts badly worn	• Adjust gear or replace defective parts
Wheel shimmy or tramp	• Improper tire pressure	• Inflate tires to recommended pressures
	• Wheels, tires, or brake rotors out-of-balance or out-of-round	• Inspect and replace or balance parts
	• Inoperative, worn, or loose shock absorbers or mounting parts	• Repair or replace shocks or mountings
	• Loose or worn steering or suspension parts	• Tighten or replace as necessary
	• Loose or worn wheel bearings	• Adjust or replace bearings
	• Incorrect steering gear adjustments	• Adjust steering gear
	• Incorrect front wheel alignment	• Correct front wheel alignment
Tire wear	• Improper tire pressure	• Inflate tires to recommended pressures
	• Failure to rotate tires	• Rotate tires
	• Brakes grabbing	• Adjust or repair brakes
	• Incorrect front wheel alignment	• Align incorrect angles
	• Broken or damaged steering and suspension parts	• Repair or replace defective parts
	• Wheel runout	• Replace faulty wheel
	• Excessive speed on turns	• Make driver aware of conditions
Vehicle leads to one side	• Improper tire pressures	• Inflate tires to recommended pressures
	• Front tires with uneven tread depth, wear pattern, or different cord design (i.e., one bias ply and one belted or radial tire on front wheels)	• Install tires of same cord construction and reasonably even tread depth, design, and wear pattern
	• Incorrect front wheel alignment	• Align incorrect angles
	• Brakes dragging	• Adjust or repair brakes
	• Pulling due to uneven tire construction	• Replace faulty tire

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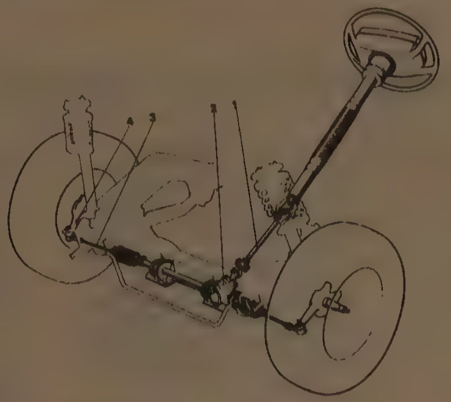

Fig. 50 Cutaway view of the manual steering components — 240, 260 series and 1980 and later models

6. Disconnect the steering gear at the steering shaft flange. Remove the steering gear. Save the dowel pins.

To install:

7. Install rubber spacers and plates for the steering gear attachment points.
8. Position the steering gear and guide the pinion shaft into the steering shaft. The recess on the pinion shaft should be aligned towards the lock bolt opening in the shaft.
9. Attach the steering gear to the front axle member. Check that the U-bolts are aligned in the plate slots. Install flat washers and nuts. Tighten the nuts to 10-18 ft. lbs. (14-24 Nm).
10. Install the splash guard.
11. Connect the steering rods to the steering arms. Tighten the nuts to 44 ft. lbs. (60 Nm).
12. Install the front wheels and lower the vehicle.
13. Install the lock bolt for the steering shaft flange. Tighten the bolt to 18 ft. lbs. (24 Nm).
14. Have the alignment checked and reset if needed.

Power Steering Gear

REMOVAL & INSTALLATION

➧ **See Figure 51**

140 and 1800 Series; 164 Models

➧ **See Figure 52**

1. Jack up the front end and support on jackstands.
2. Drain the oil from the steering pump as follows:
   a. Position a pan under the pump and remove the drain bolt from the pump.
   b. Turn the steering wheel to full left lock. Remove the cover on the fluid reservoir.
   c. Start the engine and allow it to run for a MAXIMUM of 10 seconds. This will run the pump and remove the fluid from the lines and reservoir. DO NOT run the engine without fluid in the system; the pump will become damaged.
   d. Stop the engine and turn the wheel from lock to lock until all the oil has run out. Reinstall the drain plug.
3. Remove the locknut for the Pitman arm. Disconnect the Pitman arm with a Pitman arm puller. When attaching the puller, turn the wheels fully to the right.
4. Disconnect the oil lines from the steering housing after cleaning the connections. Loosen the clamping bolt.
5. Remove the attaching bolts and pull the steering gear forwards.

To install:

6. When reinstalling, place the steering gear in the middle position. A slight increase in resistance should be felt. The line-up marks on the steering spindle and gear housing should coincide.
7. Check to make sure that the steering wheel is pointing the front wheels straight ahead.
8. Install the steering gear shaft into the lower steering column section. Install and tighten the attaching bolts. Tighten the clamping bolt. Connect the oil lines. The longer line should run in a curve to the rear and be held with a clamp.
9. Point the front wheels straight and install the Pitman arm. Torque the nut to 125-141 ft. lbs. (170-191 Nm).
10. Fill the reservoir with Type A automatic transmission fluid and bleed the system as outlined under Power Steering System Bleeding.

200 Series

➧ **See Figures 53, 54, 55, 56, 57, 58 and 59**

1. Disconnect the steering column shaft flange at the steering gearbox. Remove the clamp screw and pry the flange open.
2. Jack up the front end. Position jackstands at the front jack supports. Remove the front wheels.
3. Use a ball joint separator and disconnect the tie rods at the outer ends.
4. Remove the splash guard.
5. Disconnect the hydraulic hoses at the steering gear. Install protective plugs in the hose connections.

➡On late model 260 cars, the hose clamp on the crossmember must be removed.

6. Remove the bolts holding the steering gear. Remove the steering gear from its mounts and save the spacers.

Troubleshooting the Power Steering Gear

Problem	Cause	Solution
Hissing noise in steering gear	• There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. There is no relationship between this noise and performance of the steering. Hiss may be expected when steering wheel is at end of travel or when slowly turning at standstill.	• Slight hiss is normal and in no way affects steering. Do not replace valve unless hiss is extremely objectionable. A replacement valve will also exhibit slight noise and is not always a cure. Investigate clearance around flexible coupling rivets. Be sure steering shaft and gear are aligned so flexible coupling rotates in a flat plane and is not distorted as shaft rotates. Any metal-to-metal contacts through flexible coupling will transmit valve hiss into passenger compartment through the steering column.
Rattle or chuckle noise in steering gear	• Gear loose on frame	• Check gear-to-frame mounting screws. Tighten screws to 88 N·m (65 foot pounds) torque.
	• Steering linkage looseness	• Check linkage pivot points for wear. Replace if necessary.
	• Pressure hose touching other parts of car	• Adjust hose position. Do not bend tubing by hand.
	• Loose pitman shaft over center adjustment **NOTE:** A slight rattle may occur on turns because of increased clearance off the "high point." This is normal and clearance must not be reduced below specified limits to eliminate this slight rattle.	• Adjust to specifications
	• Loose pitman arm	• Tighten pitman arm nut to specifications
Squawk noise in steering gear when turning or recovering from a turn	• Damper O-ring on valve spool cut	• Replace damper O-ring
Poor return of steering wheel to center	• Tires not properly inflated	• Inflate to specified pressure
	• Lack of lubrication in linkage and ball joints	• Lube linkage and ball joints
	• Lower coupling flange rubbing against steering gear adjuster plug	• Loosen pinch bolt and assemble properly
	• Steering gear to column misalignment	• Align steering column
	• Improper front wheel alignment	• Check and adjust as necessary
	• Steering linkage binding	• Replace pivots
	• Ball joints binding	• Replace ball joints
	• Steering wheel rubbing against housing	• Align housing
	• Tight or frozen steering shaft bearings	• Replace bearings
	• Sticking or plugged valve spool	• Remove and clean or replace valve
	• Steering gear adjustments over specifications	• Check adjustment with gear out of car. Adjust as required.
	• Kink in return hose	• Replace hose
Car leads to one side or the other (keep in mind road condition and wind. Test car in both directions on flat road)	• Front end misaligned	• Adjust to specifications
	• Unbalanced steering gear valve **NOTE:** If this is cause, steering effort will be very light in direction of lead and normal or heavier in opposite direction	• Replace valve

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Troubleshooting the Power Steering Gear (cont.)

Problem	Cause	Solution
Momentary increase in effort when turning wheel fast to right or left	• Low oil level	• Add power steering fluid as required
	• Pump belt slipping	• Tighten or replace belt
	• High internal leakage	• Check pump pressure. (See pressure test)
Steering wheel surges or jerks when turning with engine running especially during parking	• Low oil level	• Fill as required
	• Loose pump belt	• Adjust tension to specification
	• Steering linkage hitting engine oil pan at full turn	• Correct clearance
	• Insufficient pump pressure	• Check pump pressure. (See pressure test). Replace relief valve if defective.
	• Pump flow control valve sticking	• Inspect for varnish or damage, replace if necessary
Excessive wheel kickback or loose steering	• Air in system	• Add oil to pump reservoir and bleed by operating steering. Check hose connectors for proper torque and adjust as required.
	• Steering gear loose on frame	• Tighten attaching screws to specified torque
	• Steering linkage joints worn enough to be loose	• Replace loose pivots
	• Worn poppet valve	• Replace poppet valve
	• Loose thrust bearing preload adjustment	• Adjust to specification with gear out of vehicle
	• Excessive overcenter lash	• Adjust to specification with gear out of car
Hard steering or lack of assist	• Loose pump belt	• Adjust belt tension to specification
	• Low oil level **NOTE:** Low oil level will also result in excessive pump noise	• Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage. Tighten loose connectors.
	• Steering gear to column misalignment	• Align steering column
	• Lower coupling flange rubbing against steering gear adjuster plug	• Loosen pinch bolt and assemble properly
	• Tires not properly inflated	• Inflate to recommended pressure
Foamy milky power steering fluid, low fluid level and possible low pressure	• Air in the fluid, and loss of fluid due to internal pump leakage causing overflow	• Check for leak and correct. Bleed system. Extremely cold temperatures will cause system aeriation should the oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from housing. Check welsh plug and housing for cracks. If plug is loose or housing is cracked, replace housing.
Low pressure due to steering pump	• Flow control valve stuck or inoperative	• Remove burrs or dirt or replace. Flush system.
	• Pressure plate not flat against cam ring	• Correct
Low pressure due to steering gear	• Pressure loss in cylinder due to worn piston ring or badly worn housing bore	• Remove gear from car for disassembly and inspection of ring and housing bore
	• Leakage at valve rings, valve body-to-worm seal	• Remove gear from car for disassembly and replace seals

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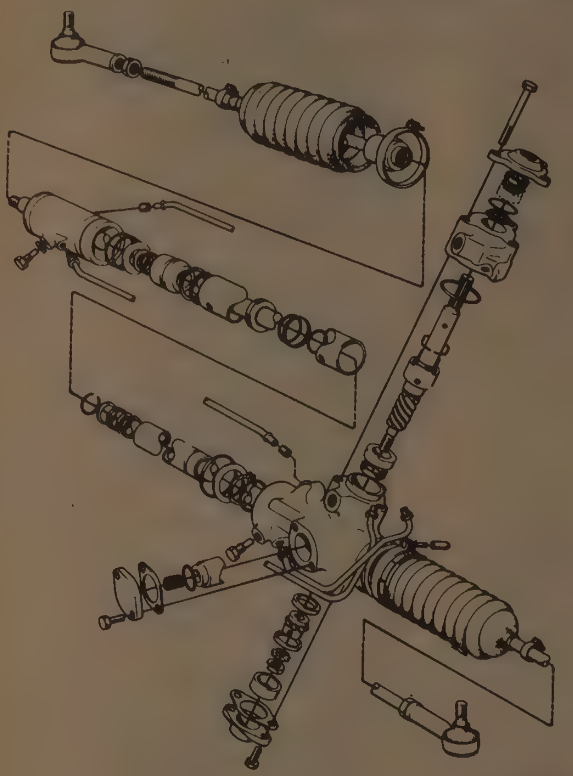

Fig. 51 Exploded view of Volvo's power rack and pinion steering gear

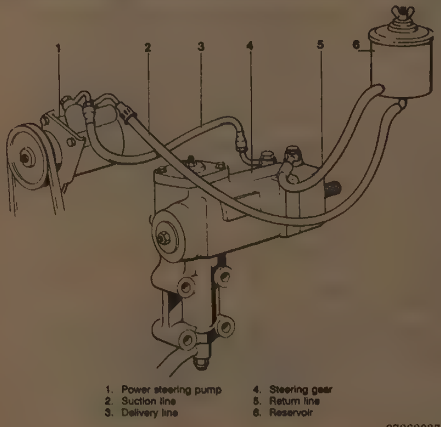

Fig. 52 Details of the power steering system — 140 and 160 series

7. Remove the steering gear from the car by pulling it down until it is free from the steering shaft flange. Then remove the unit through the left side of the vehicle. Save the dowel pins.

To install:

8. When reinstalling, position the steering gear and attach the pinion shaft to the steering shaft flange. Take care to align the recess for the lock bolt.
9. Install right side U-bolt and bracket, but do NOT tighten the nuts.
10. Install left side retaining bolts, and tighten. Tighten the U-bolts.
11. Connect the steering rods to the steering arms.
12. Install the lock bolt on the steering column flange.
13. Connect the return and pressure hoses to the steering gear. On late model 260s, secure the hose clamp to the crossmember.
14. Fill the reservoir with Type A automatic transmission fluid and bleed the system as outlined under Power Steering System Bleeding.

700 Series

1. Elevate the front end and safely support on jackstands. Place the stands at the front jacking points. Block the rear wheels.
2. Remove the splashguard and the small jacking panel on the front crossmember.
3. Disconnect the lower steering shaft from the steering gear.
4. At the lower universal joint, remove the snaprings and loosen the upper clamp bolt. Then remove the lower clamp bolt and slide the joint up on the shaft.
5. Use a ball joint separator and disconnect the tie rods at the outer ends.
6. Disconnect the fluid lines from the steering gear. Catch the spilled fluid in a pan and install plugs in the lines.
7. Remove the sway bar mounting brackets from the side members and move them out of the way. Remove the steering gear retaining bolts and lower the assembly out of the car.

To install:

8. Position the rack in position and install the retaining bolts. Tighten them to 32 ft. lbs. (43 Nm).
9. Install the sway bar mounting brackets.
10. Use new copper washers and connect the fluid lines to the assembly.
11. Connect the tie rods and tighten their nuts to 44 ft. lbs. (60 Nm).
12. Slide the lower universal joint down the shaft and into position. Tighten the lower clamp bolt first, then the upper. Both bolts are tightened to 15 ft. lbs. (20 Nm). Install the snaprings.
13. Reinstall the jacking plate and the splashguard.
14. Lower the car to the ground. Fill the reservoir with automatic transmission fluid. Start the engine and smoothly turn the steering wheel from lock to lock 3 or 4 times; recheck the fluid level in the reservoir.

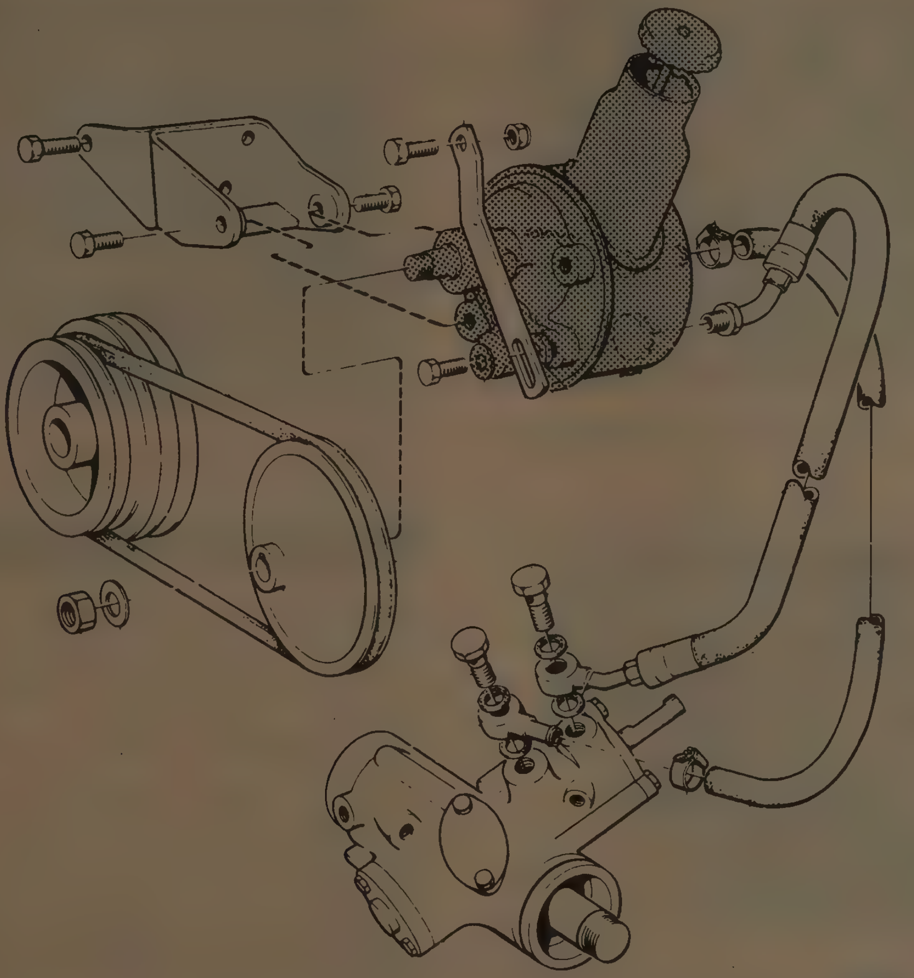

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Fig. 53 Exploded view of the Saginaw power steering pump with integrated reservoir — as found on 260 series vehicles

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Fig. 54 Remove the nut that secures the tie rod end

Fig. 55 Use a suitable tie rod end puller (such as the one shown) — the end is tapered and has a tight press fit. Hammering or prying will damage the threads, boot, etc., and still not work

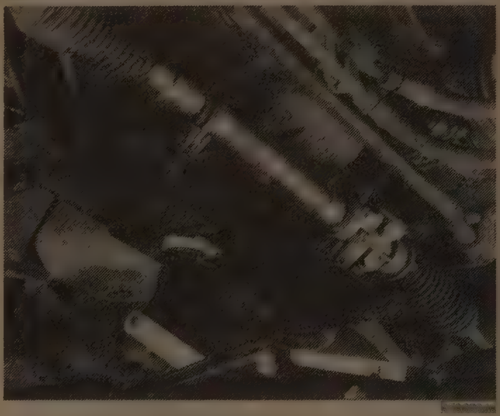

Fig. 56 The car should be jacked high enough to provide sufficient room to disconnect and remove the steering rack

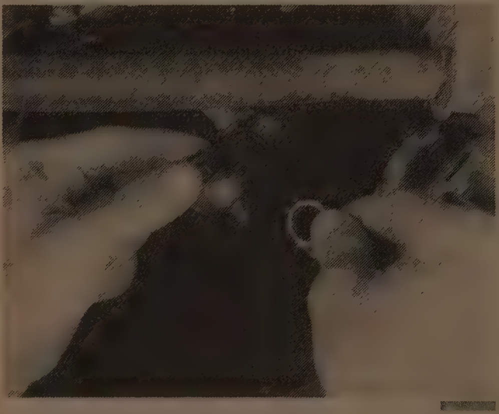

Fig. 57 Disconnect the hydraulic hoses at the steering gear, then install protective plugs in the hose connections — take care not to lose the sealing washer

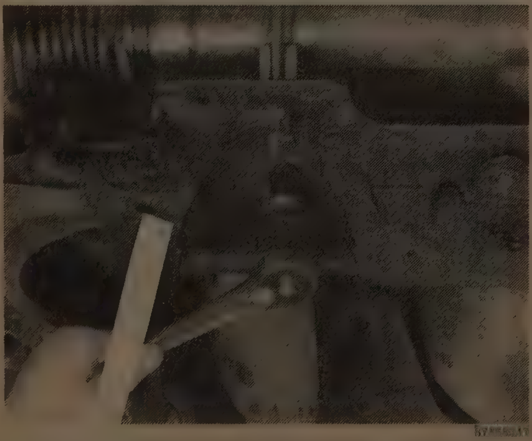

Fig. 58 Unbolt the U-bolts or securing clamp that retains the power steering rack in place to the firewall

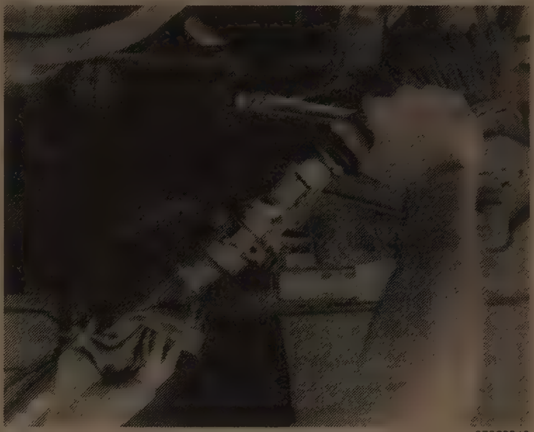

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Fig. 59 Lower the power steering rack through the left side of the vehicle — save the dowel pins

Power Steering Pump

REMOVAL & INSTALLATION

1800 and 140/160 Series

1. Remove all dirt and grease from around the line connections at the pump.
2. Using a container to catch any power steering fluid that might run out, disconnect the lines, and plug them to prevent dirt from entering the system.
3. Remove the tensioning bolt and the attaching bolts.
4. Clear the pump of the fan belt and lift it out.
5. If a new pump is to be used, the old brackets, fittings, and pulley must be transferred to the new unit. The pulley may be removed with a puller and pressed onto the new pump shaft with a press tool. Under no circumstances should the pulley be hammered on; this will damage the pump bearings.

To install:

6. Place the pump in position and loosely fit the attaching bolts. Connect the lines to the pump with new seals.
7. Place the fan belt onto the pulley and adjust the fan belt tension.
8. Tighten the tensioning bolt and the attaching bolts.
9. Fill the reservoir with Type A automatic transmission fluid and bleed the system as outlined under Power Steering System Bleeding.

200 Series

1. Remove all dirt and grease from around the line connections at the pump.
2. Using a container to catch any power steering fluid that might run out, disconnect the lines, and plug them to prevent dirt from entering the system.
3. Remove the tensioner locking screws on both sides of the pump and remove the drive belt.
4. Turn the pump up and remove the three bolts holding the bracket to the engine block. Remove the pump and bracket.

Troubleshooting the Power Steering Pump

Problem	Cause	Solution
Chirp noise in steering pump	• Loose belt	• Adjust belt tension to specification
Belt squeal (particularly noticeable at full wheel travel and stand still parking)	• Loose belt	• Adjust belt tension to specification
Growl noise in steering pump	• Excessive back pressure in hoses or steering gear caused by restriction	• Locate restriction and correct. Replace part if necessary.
Growl noise in steering pump (particularly noticeable at stand still parking)	• Scored pressure plates, thrust plate or rotor • Extreme wear of cam ring	• Replace parts and flush system • Replace parts
Groan noise in steering pump	• Low oil level • Air in the oil. Poor pressure hose connection.	• Fill reservoir to proper level • Tighten connector to specified torque. Bleed system by operating steering from right to left—full turn.
Rattle noise in steering pump	• Vanes not installed properly • Vanes sticking in rotor slots	• Install properly • Free up by removing burrs, varnish, or dirt
Swish noise in steering pump	• Defective flow control valve	• Replace part
Whine noise in steering pump	• Pump shaft bearing scored	• Replace housing and shaft. Flush system.
Hard steering or lack of assist	• Loose pump belt • Low oil level in reservoir **NOTE:** Low oil level will also result in excessive pump noise • Steering gear to column misalignment • Lower coupling flange rubbing against steering gear adjuster plug • Tires not properly inflated	• Adjust belt tension to specification • Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage. Tighten loose connectors. • Align steering column • Loosen pinch bolt and assemble properly • Inflate to recommended pressure
Foaming milky power steering fluid, low fluid level and possible low pressure	• Air in the fluid, and loss of fluid due to internal pump leakage causing overflow	• Check for leaks and correct. Bleed system. Extremely cold temperatures will cause system aeriation should the oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from body. Check welsh plug and body for cracks. If plug is loose or body is cracked, replace body.
Low pump pressure	• Flow control valve stuck or inoperative • Pressure plate not flat against cam ring	• Remove burrs or dirt or replace. Flush system. • Correct
Momentary increase in effort when turning wheel fast to right or left	• Low oil level in pump • Pump belt slipping • High internal leakage	• Add power steering fluid as required • Tighten or replace belt • Check pump pressure. (See pressure test)
Steering wheel surges or jerks when turning with engine running especially during parking	• Low oil level • Loose pump belt • Steering linkage hitting engine oil pan at full turn • Insufficient pump pressure	• Fill as required • Adjust tension to specification • Correct clearance • Check pump pressure. (See pressure test). Replace flow control valve if defective.

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Troubleshooting the Power Steering Pump (cont.)

Problem	Cause	Solution
Steering wheel surges or jerks when turning with engine running especially during parking (cont.)	• Sticking flow control valve	• Inspect for varnish or damage, replace if necessary
Excessive wheel kickback or loose steering	• Air in system	• Add oil to pump reservoir and bleed by operating steering. Check hose connectors for proper torque and adjust as required.
Low pump pressure	• Extreme wear of cam ring	• Replace parts. Flush system.
	• Scored pressure plate, thrust plate, or rotor	• Replace parts. Flush system.
	• Vanes not installed properly	• Install properly
	• Vanes sticking in rotor slots	• Freeup by removing burrs, varnish, or dirt
	• Cracked or broken thrust or pressure plate	• Replace part

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To Install:

5. If the pump is being replaced with a new one, remove the nut and pulley from the old pump and transfer it to the new one. Separate the bracket and tensioner from the pump and install them loosely on the new pump.
6. Place the pump in position on the engine and install the retaining bolts and spacer.
7. Install the drive belt and install the tensioner lock.
8. Adjust the belt tension and then tighten the nuts of the long bolts.
9. Use new copper washers and reconnect the fluid lines to the pump.
10. Fill the reservoir with Type A or Dexron®II automatic transmission fluid and bleed the system as outlined under Power Steering System Bleeding.

700 Series

See Figure 60

1. Remove the splashguard from under the engine.
2. Loosen the belt tensioner. Remove the mounting bracket and bolt.
3. Disconnect the lines at or near the pump. Depending on the type of pump, it may be necessary to disconnect the rubber hose(s) from the metal pipes instead of removing the lines at the pump body. Use a catch pan under the car for spillage and plug the lines and fittings immediately to avoid contamination.
4. Remove the large retaining bolt and remove the drive belt from the pump.
5. Lower the pump slightly and disconnect the filler hose from the pump. Remove the pump from the car.

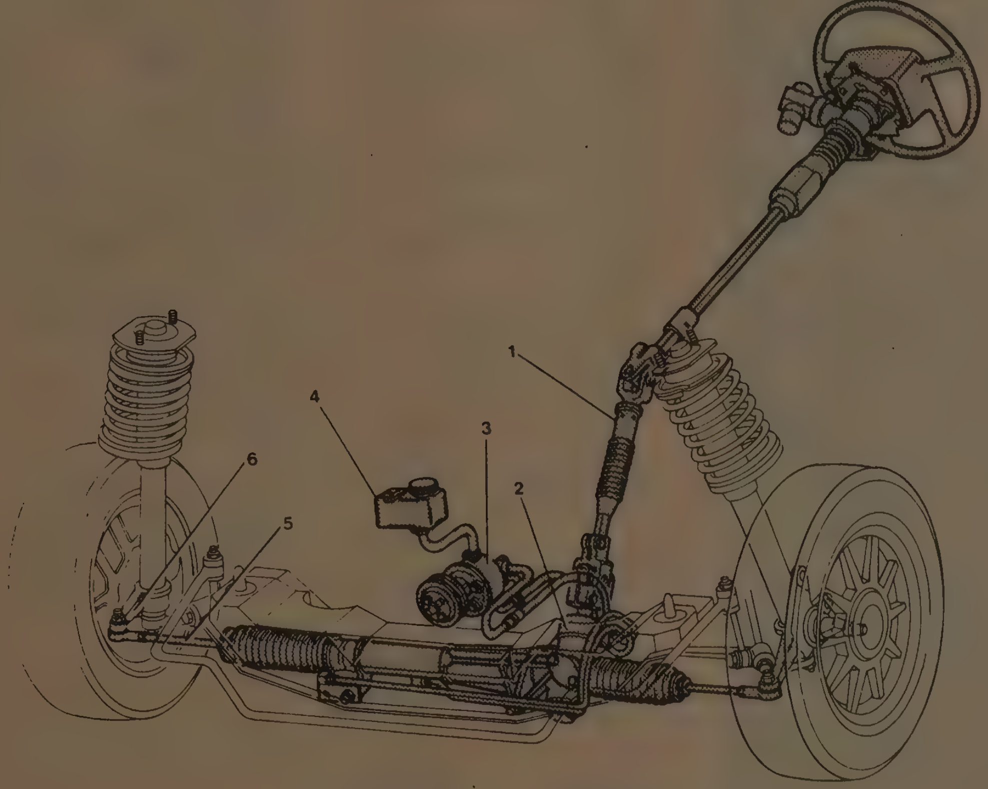
To Install:

6. If the pump is to be replaced with a new one, transfer the pulley, the mounting bracket and the washers to the new pump. Install the mounting bracket on the new pump; make sure the thick washer is between the bracket and the pump body. Install the pulley; remember that the conical face of the washer must be to the outside.
7. Reconnect the filler hose to the pump.
8. Position the pump and install the retaining bolts loosely.
9. Install the mounting bracket and belt. Adjust the belt tension.
10. Tighten the lower retaining bolts.
11. Reconnect the fluid hoses to the pump. Use new washers and/or hose clamps. Tighten the banjo fittings (if any) to 31 ft. lbs. (42 Nm).
12. Fill the fluid reservoir and start the engine. Slowly turn the wheel lock to lock once or twice and check for leaks. Top the fluid to the proper level.
13. Reinstall the splashguard. The power steering system is self-bleeding; no external bleeding is required.

POWER STEERING SYSTEM BLEEDING

Bleeding removes any air which become trapped within the fluid system. The system should be bled every time any hose or component has been loosened or removed. The system should also be bled if it has run low on fluid during operation.

1. Fill the reservoir with the proper type of fluid. Raise the front wheels off the ground, and install jackstands. Place the transmission in neutral and apply the parking brake.
2. Keeping a can of fluid within easy reach, start the engine and fill the reservoir as the level drops.
3. When the reservoir level has stopped dropping, slowly turn the steering wheel from lock-to-lock several times. Fill the reservoir if necessary.
4. Locate the bleeder screw (non-rack and pinion steering models only) on the power steering gearbox. Open the bleeder screw about $^3/_4$ turn, and close it when oil starts flowing out.
5. Continue to turn the steering wheel slowly until the fluid in the reservoir is free of air bubbles.
6. Stop the engine and observe the oil level in the reservoir. If the oil level rises more than $^1/_4$ in. (6mm) past the level mark, air still remains in the system. Continue bleeding until the level rise is correct.
7. Remove the jackstands and lower the car.



1. Steering shaft
2. Steering gear
3. Pump
4. Reservoir
5. Steering rod
6. Steering arm

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Fig. 60 Cutaway view of the power steering system — 700 series

Troubleshooting Basic Steering and Suspension Problems

Problem	Cause	Solution
Hard steering (steering wheel is hard to turn)	• Low or uneven tire pressure	• Inflate tires to correct pressure
	• Loose power steering pump drive belt	• Adjust belt
	• Low or incorrect power steering fluid	• Add fluid as necessary
	• Incorrect front end alignment	• Have front end alignment checked/adjusted
	• Defective power steering pump	• Check pump
	• Bent or poorly lubricated front end parts	• Lubricate and/or replace defective parts
Loose steering (too much play in the steering wheel)	• Loose wheel bearings	• Adjust wheel bearings
	• Loose or worn steering linkage	• Replace worn parts
	• Faulty shocks	• Replace shocks
	• Worn ball joints	• Replace ball joints
Car veers or wanders (car pulls to one side with hands off the steering wheel)	• Incorrect tire pressure	• Inflate tires to correct pressure
	• Improper front end alignment	• Have front end alignment checked/adjusted
	• Loose wheel bearings	• Adjust wheel bearings
	• Loose or bent front end components	• Replace worn components
	• Faulty shocks	• Replace shocks
Wheel oscillation or vibration transmitted through steering wheel	• Improper tire pressures	• Inflate tires to correct pressure
	• Tires out of balance	• Have tires balanced
	• Loose wheel bearings	• Adjust wheel bearings
	• Improper front end alignment	• Have front end alignment checked/adjusted
	• Worn or bent front end components	• Replace worn parts
Uneven tire wear	• Incorrect tire pressure	• Inflate tires to correct pressure
	• Front end out of alignment	• Have front end alignment checked/adjusted
	• Tires out of balance	• Have tires balanced

9

BRAKES

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BRAKE OPERATING SYSTEM

All Volvos are equipped with a four wheel power-assisted disc brake system. Volvo was one of the first manufacturers to commit to the four wheel disc system on all of its cars. Disc brakes offer better stopping, ease of repair and simplified construction.

The calipers are manufactured either by Girling or ATE, so when ordering disc pads or caliper rebuilding kits, you must identify which you have. The name of the manufacturer is cast into the metal of the caliper. The brake discs are one piece castings. The discs on some models are vented for quicker heat dispersion.

Whenever adding to or replacing the brake fluid, it is imperative that the fluid be of SAE 70 R3 (SAE J 1703) quality or better. Fluid meeting DOT 3 or DOT 4 specifications is also acceptable. Using inferior brake fluids may result in premature failure of the hydraulic components or in impaired braking function. Fluids not meeting specifications may not withstand the great temperatures generated at the disc and caliper during braking. If the fluid boils within the lines, the pedal will feel spongy and give little response at the wheels.

Brake fluid is said to be hygroscopic, meaning that it attracts moisture. Water is the absolute last substance you want in the brake system, as it causes corrosion and can ruin seals. Any time it is necessary to add brake fluid, always use a fresh can. That half full can on the shelf has been through many heating and cooling cycles in the last six months; enough moisture has condensed out of the air within the can to pollute the fluid. You can use this old fluid for cleaning components during disassembly, but don't introduce any into the fluid system. Avoid mixing brake fluids from different manufacturers and never reuse old brake fluid.

In 1987, Volvo introduced its Anti-lock Braking System (ABS) on models in the 700 Series. This system prevents wheel lock-up (skidding) during hard braking, thus allowing the car to be steered during an emergency situation. (A wheel which is not turning will not provide steering response.) The ABS system uses a combination of mechanical, electronic and hydraulic components to sense impending lock-up at each wheel and meter the brake fluid flow to the wheels.

There are certain differences in repair procedures for ABS and non-ABS components. The ABS procedures, if different, are explained separately at the end of each repair section.

Anti-lock Brake System (ABS)

The ABS system comprises many components including sensors, pulse-wheels, the hydraulic modulator and the Electronic Control Unit (ECU). The ECU is the "brain" of the system while the modulator performs the actual work of controlling the fluid flow to each wheel. Testing of the system requires specific dealer-only equipment. The hydraulic unit, located either in the trunk or under the hood, is connected to a maze of brake lines. Don't attempt to loosen, bleed or repair anything at this unit.

Under very hard braking, you may hear unusual sounds from the hydraulic modulator; this is quite normal and is simply a result of the unit doing its job.

The ABS warning light on the dash should not be confused with the brake warning light. If the ABS light comes on, it indicates a fault in the Anti-lock system, not the main braking system. The car can be safely driven, but will not have the benefit of the ABS system. If the brake warning light comes on, the braking system may be impaired due to fluid loss in the system. In this case braking may be reduced; diagnosis and repair is required immediately and caution should be used when driving.

ADJUSTMENT

Disc brakes are inherently self adjusting. The only adjustment needed will be for the parking brakes, which are small brake shoes located in the hub drum of the rear disc brake rotors. See the end of this section for procedures.

Brake Light Switch

REMOVAL & INSTALLATION

➧ See Figure 1

The switch controlling the brake lights is located at the brake pedal. As the pedal moves from its rest position, the switch engages and turns on the brake lights. To change the switch, simply unplug the connectors at the switch, unscrew the locknut and remove the switch.

After installing the new switch, it must be adjusted so that the switch engages (brake lights come on) after 3/8-1/2 in. (9-12mm) of pedal travel. With the brake pedal in the released position, the distance (A) between the brass hub of the switch and the pedal lever should be 0.08-0.24 in. (2-6mm). To adjust, loosen the attaching screws for the switch bracket and move the switch in the required direction.

Master Cylinder

REMOVAL & INSTALLATION

1970-73 140 Series

➧ See Figure 2

1. To prevent brake fluid from spilling onto and damaging the paint, place a protective cover over the fender apron, and rags beneath the master cylinder.

➡Siphon the fluid out of the reservoir prior to removal to minimize spillage.

2. Disconnect the brake lines from the master cylinder and plug them immediately.
3. Remove the two nuts which retain the master cylinder and reservoir assembly to the vacuum booster, and lift the

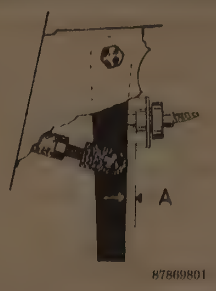

Fig. 1 Adjust the stoplight switch within dimension "A"

assembly forward, being careful not to spill any fluid on the fender. Empty out and discard the brake fluid.

✻✻CAUTION

Do not depress the brake pedal while the master cylinder is removed.

➡In order for the master cylinder to function properly when installed to the vacuum booster, the adjusting nut for the thrust rod of the booster must not prevent the primary piston of the master cylinder from returning to its resting position.

4. A clearance (C) of 0.020-0.059 in. (0.5-1.5mm) is required between the thrust rod and primary piston with the master cylinder installed. The clearance may be adjusted by rotating the adjusting nut for the booster thrust rod in the required direction.
5. To determine what the clearance (C) will be when the master cylinder and booster are connected, first measure the distance (A) between the face of the attaching flange and the center of the primary piston on the master cylinder.
6. Then measure the distance (B) that the thrust rod protrudes from the fixed surface of the booster (making sure that the thrust rod is depressed fully with a partial vacuum existing in the booster).
7. When measurement (B) is subtracted from measurement (A), clearance (C) should be obtained. If not, adjust the length of the thrust rod by turning the adjusting screw to suit.
8. After the final adjustment is obtained, apply a few drops of locking compound to the adjusting nut.
9. Position the master cylinder and reservoir assembly onto the studs for the booster, and install the washers and nuts. Tighten the nuts to 17 ft. lbs. (23 Nm).
10. Remove the plugs and connect the brake lines.
11. Bleed the entire brake system.

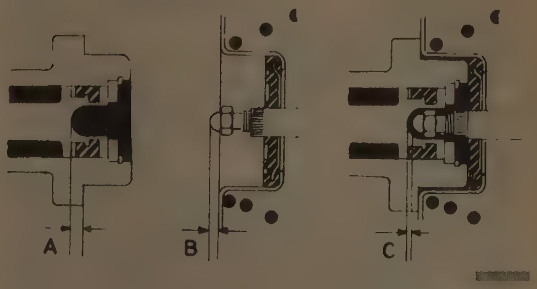

Fig. 2 Adjust the brake booster thrust rod as necessary, so that dimension (A) minus (B) = (C) — 1970-73 140 series

1974 140 and 164; All 1800, 200 and 700 Series

▶ See Figures 3, 4, 5, 6, 7 and 8

1. To prevent brake fluid from spilling onto and damaging the paint, place a protective cover over the fender apron, and rags beneath the master cylinder.

➡Siphon the fluid out of the reservoir prior to removal to minimize spillage.

2. Label and disconnect the brake lines from the master cylinder and plug them immediately. If the vehicle has a hydraulic clutch, disconnect its line from the fluid reservoir. Plug it and secure the line out of the way.
3. Remove the two nuts which retain the master cylinder and reservoir assembly to the vacuum booster, and lift the

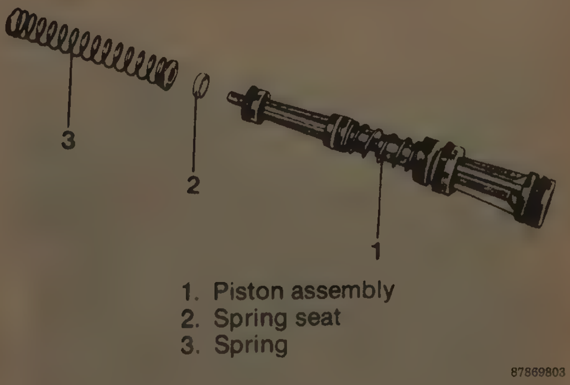

Fig. 3 Exploded view of the master cylinder piston assembly — 240, 260 and 1980 and later models

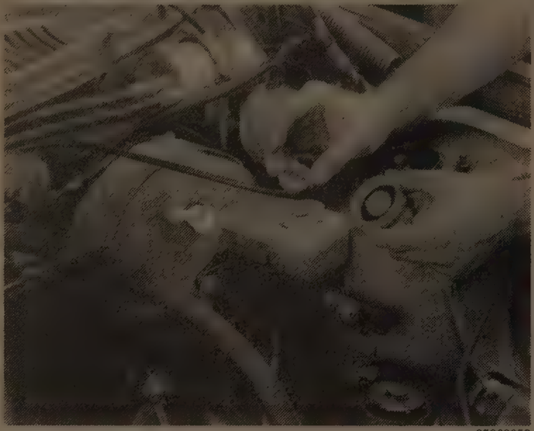

Fig. 4 Remove the cap and the debris trap to remove the fluid prior to master cylinder removal

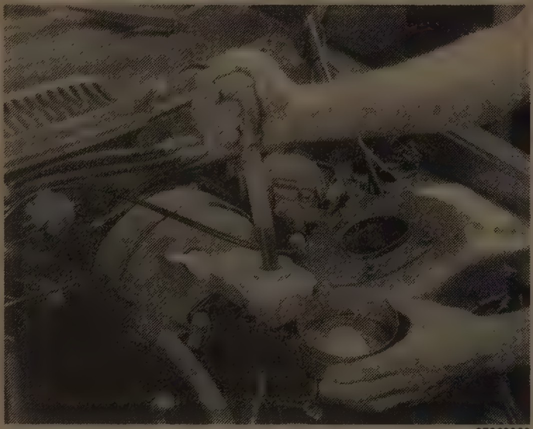

Fig. 5 An ordinary turkey baster works well as a mini-siphon to remove the brake fluid

Fig. 6 Remove the lines by detaching the flange fittings — use a catch pan to prevent fluid from spilling onto the engine components below

assembly forward, being careful not to spill any fluid on the fender. Empty out and discard the brake fluid.

✱✱WARNING

Do not depress the brake pedal while the master cylinder is removed!

4. To install, place a new sealing rim (if equipped) onto the sealing flange of the master cylinder. Position the master cylinder and reservoir assembly onto the booster studs, and install the washer and nuts. Tighten the nuts to 9-11 ft. lbs. (12-15 Nm).

5. Remove the plugs and loosely connect the brake lines. Have a helper depress the brake pedal to remove air from the cylinder. Tighten the nuts for the lines when the brake fluid (free of air bubbles) is forced out. Reconnect the lines for the hydraulic clutch if so equipped.

6. Bleed the entire brake system. If the car has a hydraulic clutch, bleed the clutch system.

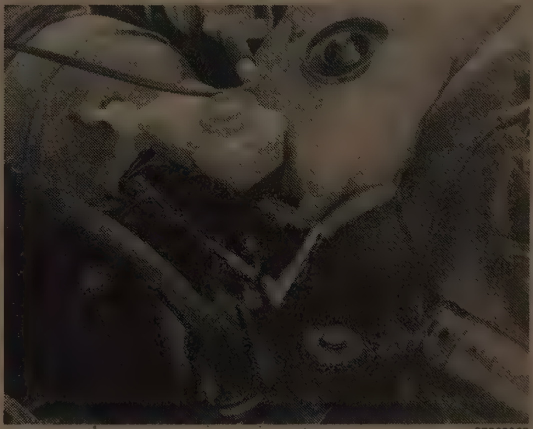

Fig. 7 Unbolt the master cylinder from the brake booster as shown

Fig. 8 Remove the detached master cylinder from the brake booster

OVERHAUL

164 and 1800 Series

1. Remove the master cylinder from the booster.
2. Firmly fasten the flange of the master cylinder in a vise.
3. Position both hands beneath the reservoir and pull it free of its rubber seals. Remove the filler cap and strainer from the reservoir, as well as the rubber seals and nuts (if so equipped) from the cylinder.
4. Remove the stop screw. Using a pair of snapring pliers, remove the snapring from the primary piston and shake out the pistons.
5. Discard both the primary and secondary pistons.
6. Clean all reusable metal parts in clean brake fluid or methylated alcohol. The parts must be thoroughly dried with filtered, water-free compressed air, or air dried. All cleaning alcohol must be removed from the parts, as it lowers the boiling temperature of brake fluid. If the inside of the cylinder is scored or scratched, the cylinder must be replaced. Minor pitting and corrosion may be removed by honing. Remember to flush the cylinder clean after honing, and make sure that the passages are clear. Check the cylinder bore for excessive wear.
7. Make sure that the new rubber seals, a new brass washer and back-up ring are installed on the new secondary piston. Make sure that the rubber seals are pointing in the right direction.
8. Coat the cylinder bore with brake fluid and dip the secondary piston and seals in brake fluid prior to installation. Install the secondary piston and spring in the bore, taking care not to damage the rubber seals.
9. Make sure that the new rubber seals, metal washers, plastic washer, back-up ring, sleeve, and springs are installed on the new primary piston. Make sure that the seals are facing in the right direction.
10. On 1800 models, compress the primary piston spring and tighten the screw for the sleeve until it bottoms. Tighten the screw to 1.5-2.2 ft. lbs. (2-3 Nm).
11. Dip the primary piston assembly in brake fluid and install it in the bore, taking care not to damage the rubber seals. While holding the piston in the bore, install the snapring.
12. Check that the hole for the stop screw is clear, and install the new stop screw and sealing washer. Tighten the screw to 3.5-5.7 ft. lbs. (4.75-7.75 Nm) on all 164 and 1800 series.
13. Check the movement of the pistons and make sure that the flow-through holes are clear. The equalizing hole is checked by inserting a 25 gauge (1800) or 22 gauge (164) soft copper wire through it and making sure that it is not blocked by the secondary piston seal. If it is blocked, the master cylinder will not function properly and must be reassembled.
14. Install the nuts (if so equipped), new rubber seals and washers onto the master cylinder at the reservoir connections. After making sure that the venting hole in the cap is open, install the cleaned strainer and cap. Press the reservoir into the master cylinder by hand.
15. Install the master cylinder.

140, 200 and 700 Series — Non-ABS System

➧ **See Figures 9, 10, 11, 12 and 13**

1. Remove the master cylinder from the booster as outlined in this section.
2. Firmly fasten the flange of the master cylinder in a vise.
3. Position both hands beneath the reservoir and pull it free of its rubber seals. Remove the filler cap and strainer from the reservoir, as well as the rubber seals and nuts (if so equipped) from the cylinder.
4. Remove the stop screw. Using a pair of snapring pliers, remove the snapring from the primary piston and shake out the piston.
5. Remove both the seal from the secondary piston, taking care not to damage or score the surfaces of the plunger. The old primary piston should be discarded and replaced.
6. Clean all reusable metal parts in clean brake fluid or methylated alcohol. The parts may be allowed to thoroughly air dry, or compressed air may be used. All alcohol must be removed from the parts, as alcohol lowers the boiling tempera-

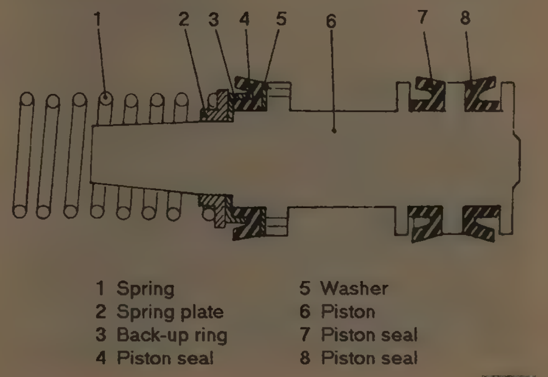

Fig. 9 Cross-sectional view of the type 2 secondary piston — 140 series

Fig. 10 Place the master cylinder firmly in a vise

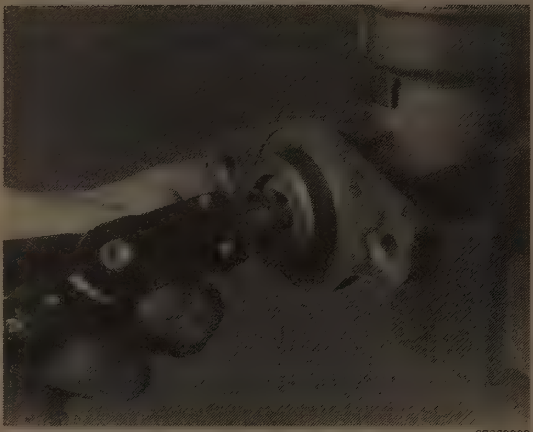

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Fig. 11 Using a pair of snapring pliers, remove the snapring from the primary piston

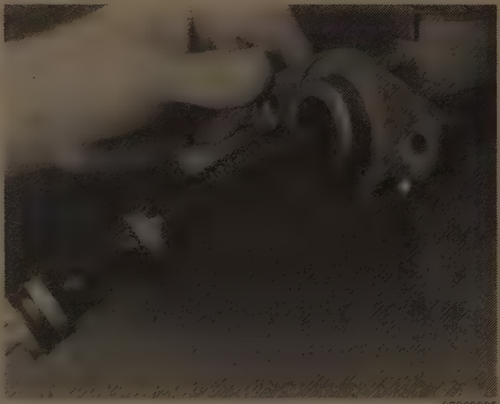

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Fig. 12 Pull out the primary pistion assembly and shake off any excess brake fluid into a drain pan — do not allow the fluid to contact painted surfaces

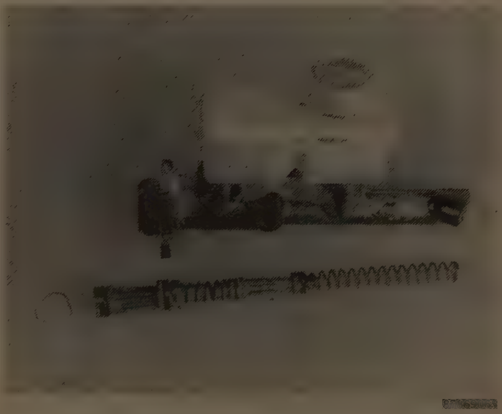


Fig. 13 The master cylinder disassembled — ONLY allow fresh brake fluid to contact the components. NO other cleaners or solvents are acceptable

ture of brake fluid. If the outside of the cylinder is scored or scratched, the cylinder must be replaced. Minor pitting or corrosion may be removed by honing. Remember to flush the cylinder clean after honing, and make sure that the passages are clear. Check the piston for damage and proper clearance in the bore.

7. Install new seals on the secondary piston, making sure that they are positioned in the proper direction.
8. Coat the cylinder bore with brake fluid and dip the secondary piston and seals in brake fluid prior to installation. Slide the spring, spring plate, and washer onto the secondary piston and install the assembly in the bore, taking care not to damage the seals. Dip the new primary piston and seal assembly in brake fluid. Press the primary piston assembly into the bore and install a new washer and snapring.
9. Make sure that the hole for the stop screw is clear and install the new top screw and sealing washer.
10. Check the movement of the pistons and make sure that the flow-through holes are clear. The equalizing hole (140 series only) is checked by inserting a 25 gauge soft copper wire through it and making sure that it is not blocked by the secondary piston seal. If it is blocked, then the master cylinder in incorrectly assembled, and you must take it through the numbers again.
11. Install the nuts (if so equipped), new rubber seals, and washers onto the master cylinder at the reservoir connections. After making sure that the venting hole in the cap is open, install the cleaned strainer and cap. Press the reservoir into the master cylinder by hand.
12. Install the master cylinder.

ABS System

1. Remove the master cylinder as described previously. Drain and remove the fluid reservoir. Remove the two seals between the reservoir and the cylinder.
2. Remove the washer in the front hole of the cylinder.
3. To disassemble the master cylinder, press the pistons into the cylinder while using a pair of long-nosed pliers to remove the locking pin through the front hole.
4. After the lock pin is removed, remove the lock ring for the pistons and remove the pistons.
5. Clean all reusable metal parts in methylated alcohol. The parts may be allowed to thoroughly air dry, or compressed air may be used. All alcohol must be removed from the parts, as alcohol lowers the boiling temperature of brake fluid. If the bore of the cylinder is scored or scratched, the cylinder must be replaced. Minor pitting or corrosion may be removed by honing. Remember to flush the cylinder clean after honing, and make sure that the passages are clear. Check the piston for damage and proper clearance in the bore.
6. Install the pistons into the cylinder. Turn the oval opening of the front stage so that it faces the fluid reservoir hole.
7. Press the pistons in to the bottom of the cylinder and install the lock pin through the front hole. Release the pistons and check that the lock pin holds the front stage.
8. Press the pistons inward again and install the lock ring.
9. Install the washer in the front hole and reinstall the two sealing rings. Use new rings if any damage is seen.
10. Install the master cylinder.
11. Bleed the brakes.

Power Brake Booster

All models are equipped with a mechanical tandem-type power booster device located between the brake pedal and the master cylinder. Either intake manifold vacuum (models through 1974) or a camshaft driven vacuum pump (1975 and later models) is used to supply power to the booster. When the brake pedal is pushed, the vacuum acts on a diaphragm inside the booster; this in effect amplifies the brake pedal pressure.

REMOVAL & INSTALLATION

➧ **See Figure 14**

1. Remove the master cylinder, following previously listed procedures. On 140 Series, remove the ignition coil if it is in the way.
2. Disconnect the vacuum hose and the check valve from the brake booster. The check valve is a press fit and may be removed with gentle prying.
3. On 700 Series, loosen the fuel filter from its mounts and move it aside. Remove the vacuum pump.
4. Disconnect the link from the brake pedal. Remove the bracket with the clutch pedal stop.
5. Remove the retaining nuts (4), pull the power booster forward and disconnect fork from the link arm.
6. The brake booster is non-serviceable; any failure requires replacement of the complete unit. To reinstall, transfer any necessary parts to the new unit. Remember to transfer the rubber seal for the check valve. Make sure it is properly seated in its groove.
7. Install a new sealing ring on the booster. (The DBA 9 in. (228mm) booster found on some 200 Series does not have a ring; it requires sealing compound to be applied to the firewall.)
8. Attach the brake booster to the firewall. Connect the brake rod to the pedal. Secure the soundproofing under the dash.

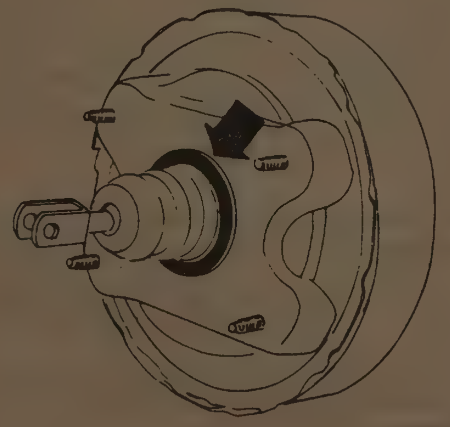


Fig. 14 Remember to position the seal when installing the power brake booster

9. Install the master cylinder. Connect the check valve and the vacuum hose.
10. On 700 Series, reinstall the fuel filter and the vacuum pump. On 200 series, reinstall the ignition coil if it was removed.
11. Bleed the brake system completely.

Vacuum Pump

REMOVAL & INSTALLATION

Gasoline Engines

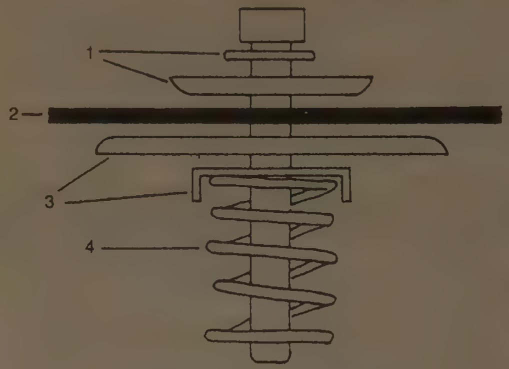
➧ **See Figure 15**

1. Disconnect the hose from the vacuum pump. Remove the four bolts and remove the pump from the engine.
2. Remove the upper cover, the seal, and the valve springs. Note and MARK the valve positions; they face in different directions in the cover. Remove the valves and the seals below them.
3. Matchmark the upper and lower halves of the pump assembly. This is essential for proper reassembly. A felt-tip marker works well. Remove the eight screws and separate the halves of the pump.
4. Remove the center screw, the washer, the diaphragm, the washers and the spring.
5. Remove the lower cover and the axle (pivot) pin for the pump arm. Place a shim such as a feeler gauge between the arm and the lever; this will prevent the arm from bending during removal of the pin.
6. Remove the pump rod and lever arm. Clean the parts and check them for damage. Pay close attention to the condition of the needle bearing for the pump arm.
7. To reassemble, fit the pump rod and lever arm into the housing and press in the axle pin. Use a shim to support the bracket while pressing the pin in. Put a drop of locking compound onto the ends of the pin to secure it.
8. Reinstall the bottom cover and seal.
9. Assemble onto the center screw the washers, the diaphragm, the other washers and the spring. Make certain the washers are in the correct position.
10. Hold the pump upside down and fit the screw with the parts on it. Make sure everything lines up and seats properly.
    a. Reassemble the pump halves; use the matchmarks to position the halves.
11. Install the seals.
12. Observe the marks made during removal and install the valves. Make sure they face in different directions.
13. Install the valve springs, the seal and the cover.
14. Use a new gasket and install the vacuum pump to the motor. Connect the vacuum hoses.

Diesel Engines

➧ **See Figure 16**

1. Remove the hoses from the pump body. Remove the retaining bolts and lift the pump from the cylinder head. Remove the plunger from the cylinder head and thoroughly clean the pump.



1 Washers
2 Diaphragm
3 Washers
4 Spring

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Fig. 15 Internal parts of the gasoline engine vacuum pump — be sure to install the washers correctly

2. Matchmark the pump body and the cover. This is essential to correct reassembly.

3. Remove the screws (1), the cover (2) and the gasket (3). Lift out the intermediate piece (11), the filler piece (10), both valves (12 and 13) and all three washers (14).

4. Use a valve spring compressor tool (Volvo 6052 or similar) to press the diaphragm rod spring down about 0.4 in. (10mm). Unscrew the nut (4) while holding the hexagonal head of the rod stationary.

5. Release the compressor tool and remove the diaphragm rod (21), the washer (17), the O-ring (16) and the bushing (15).

6. Use the diaphragm rod to press out the plunger (6 or 6a) and the plunger disc (9). Remove the O-ring (7) and the piston ring (8). (6a is a one-piece plunger; it will not have an O-ring or piston ring.)

7. Clean all reusable parts and inspect for damage. The intermediate piece should be 0.59-0.60 in. (15.0-15.2mm) in height. The filler piece should be 1.02-1.03 in. (25.9-26.1mm) in height. Replace any worn or faulty parts.

8. Lubricate any new components with engine oil. Install the bushing (15), the O-ring (16) and the washer (17).

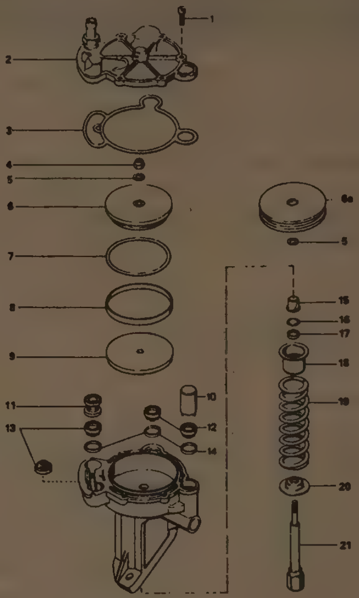
9.Lubricate the diaphragm rod (21) and install it along with the spring plate (20), the spring (19) and the spring cup.

9. Use the compressor tool and tension the spring so that the threaded end of the diaphragm rod extends about 0.2 in. (5mm) above the pump flange surface. Align the rod so that it is perpendicular to the flange.

10. Install the piston plate (9) on the diaphragm rod. Make sure the **APG** mark faces out.

11. Lightly lubricate the piston bore; insert the piston with its piston ring and O-ring (6,7, 8 or 6a) and be very careful not to damage the piston ring.

➡On pumps with one-piece pistons (6a), insert the tapered end of the piston on top of the small washer (5).



1. Screws
2. Cover
3. Gasket
4. Nut
5. Washer
6. Piston
6a. One-piece piston
7. O-ring
8. Piston ring
9. Plunger disc
10. Filler piece
11. Intermediate piece
12. Valve
13. Valve
14. Washers
15. Bushing
16. O-ring
17. Washer
18. Spring cup
19. Spring
20. Spring plate
21. Diaphragm rod

Fig. 16 Exploded view of the diesel engine vacuum pump (and legend)

12. Install a new locknut (4) and washer (5) onto the end of the diaphragm rod.

13. Relieve the tension on the spring so that the bottom of the rod contacts the housing. Hold the rod stationary and tighten the locknut to 7 ft. lbs. (9.5 Nm)

14. In the pump body, install the three washers (14), the two valves (12 and 13), the intermediate piece (11) and the filler piece (10).

➡After rebuilding the pump, the inlet valve is sealed by the large gasket (3), not by a separate smaller gasket.

15. Install a new gasket (3) on the housing, install the cover (2) and tighten the screws in a diagonal pattern to 22-37 ft. lbs. (30-50 Nm).

16. Install the plunger and vacuum pump on the cylinder head. Tighten the mounting bolts and connect the vacuum hoses.

Warning Valves

See Figure 17

REMOVAL & INSTALLATION

The brake system warning valve is located near the master cylinder in the engine compartment on 1973-77 models. On 1978 and later models it is located under a bolt on the front axle member. The 700 Series vehicles without ABS have the unit mounted on the left front shock tower. The valve is centered by hydraulic pressure from the primary circuit on one side and the secondary circuit on the other.

When a hydraulic imbalance occurs, such as a leak in one of the calipers, the valve will move off-center toward the system with the lower pressure. When the valve moves off-center, it closes a circuit to a warning light on the dashboard, warning the driver of the imbalance. Sometimes, the valve will actuate the warning light when one of the systems is bled during normal maintenance. When this happens, the valve has to be reset.

Cars with ABS do not use this system. The pressure sensing circuit is built into the hydraulic unit. In case of system leakage, a sensor within the cap of the brake fluid reservoir will close a switch and illuminate the dash warning light.

If the valve must be replaced:

1. Place a rag beneath the valve to catch the brake fluid, loosen the pipe connections, label and disconnect the six brake lines. Disconnect the electrical plug contact, and lift out the valve.
2. Connect the new warning valve in the and connect the plug contact.
3. Bleed the entire brake system.

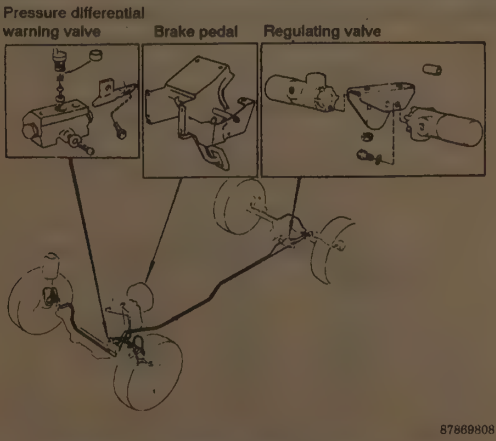


Fig. 17 Location of brake system valves on the chassis — common 200 series shown

VALVE RESETTING

1800, 100 and 200 Series

1. Disconnect the plug contact and screw out the warning switch so that the pistons inside the valve may return to their normal position.
2. Repair and bleed the faulty hydraulic circuit.
3. Screw in the warning switch and tighten it to a torque of 10-14 ft. lbs. (13-19 Nm). Connect the plug contact.
4. When the system has been bled, depress the brake pedal firmly (simulating a hard stop) for about a minute. Check that there has been no leakage at the warning switch threads. If any leakage — no matter how slight — is found, replace the valve assembly.

➡The non-ABS 700 Series vehicles do not require this procedure. The valve will self-center once equal pressures have been restored within the system.

Proportioning Valves

Each of the brake circuits has a proportioning (relief) valve located inline between the rear wheels. The purpose of this valve is to ensure that brake pressure on all four wheels compensates for the change in weight distribution under varied braking conditions.

The harder the brakes are applied, the more weight there is on the front wheels. The valve regulates the hydraulic pressure to the rear wheels so that under hard braking conditions they receive a smaller percentage of the total braking effort. This prevents premature rear wheel lockup and possible skidding or loss of control.

REMOVAL & INSTALLATION

1800, 100 and 200 Series

See Figure 18

Sophisticated pressure testing equipment is required to troubleshoot the dual hydraulic system, in order to determine if the proportioning valve(s) are in need of replacement. However, if the car is demonstrating signs of rear wheel lock-up under moderate-to-heavy braking, and other variables such as tire pressure, tread depth, etc., have been ruled out, the valve(s) may be at fault. The valves are not rebuildable and must be replaced as a unit.

To replace the valve:

1. At the proportioning valve, disconnect and plug the brake lines coming from the front of the car.
2. Loosen the connection for the flexible brake hose to the rear wheel a maximum of ¼ turn. This will allow some flex in the hose during removal.
3. Remove the bolt(s) which retain the valve to the underbody, and unscrew the valve from the rear brake hose.
4. To install the valve, place a new seal on it, and screw the valve onto the rear brake hose and hand tighten. Secure the valve to the underbody with the retaining bolts(s).

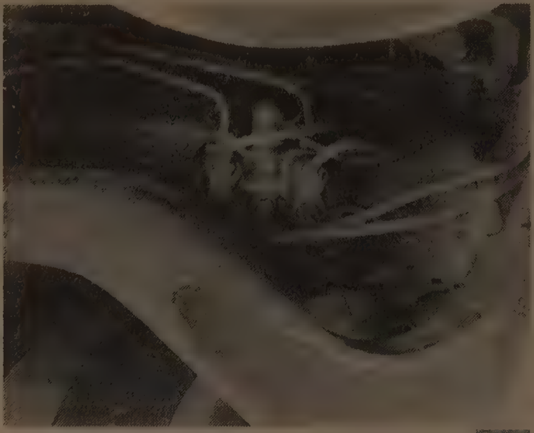


Fig. 18 Do not replace the brake proportioning valve, unless all other possibilities have been ruled out

5. Connect the brake lines from the front of the car and tighten both connections, making sure that there is no tension on the flexible rear hose.
6. Snug the connection to the rear brake hose, but do not overtighten.
7. Bleed the brake system.

Brake Hoses

REMOVAL & INSTALLATION

See Figures 19 and 20

Metal lines and rubber brake hoses should be checked frequently for leaks and external damage. Metal lines are particularly prone to crushing and kinking under the car. Any such deformation can restrict the proper flow of fluid and therefore impair braking at the wheels. Rubber hoses should be checked for cracking or scraping; such damage can create a weak spot in the hose and it could fail under pressure.

Any time the lines are removed or disconnected, extreme cleanliness must be observed. The slightest bit of dirt in the system can plug a fluid port and render the brakes defective. Clean all joints and connections before disassembly (use a stiff brush and clean brake fluid) and plug the lines as soon as they are disconnected. New lines and hoses should be blown or flushed clean before installation to remove any contamination. To replace a line or hose:

1. Clean the surrounding area on the joints to be disconnected.
2. To reduce fluid spillage during the repair, either plug the vent hole in the reservoir cap or substitute another cap without a vent hole.
3. Disconnect the hose or line to be replaced. If disconnecting rubber hoses at the brake caliper, use a suitable clamp to pinch the rubber hose shut to prevent fluid loss. If completely removing the hose(s), label or identify each hose so that it may be replaced in the same location. Plug the line ends as soon as the joint is disconnected.
4. Install the new line paying close attention to the proper routing and installation of any retaining clips. Make sure the new line will not rub against any other parts. Brake lines must be at least $\frac{3}{8}$ inch (10mm) away from the steering column.

➡If the new line requires bending, do so gently using a pipe bending tool. Do not attempt to bend the tubing by hand; it will kink the pipe and render it useless.

5. Remove the line plugs and tighten the line connections at both ends.
6. Bleed the brake system beginning with the wheel closest to the replaced line or hose.

Bleeding Brake System

See Figures 21, 22, 23, 24 and 25

Whenever a spongy brake pedal indicates that there is air in the system, or when any part of the hydraulic system has been removed for service, the system must be bled. In addi-

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Fig. 19 These special hose pinch-clamps are ideal for preventing brake fluid from leaking out of the rubber hoses

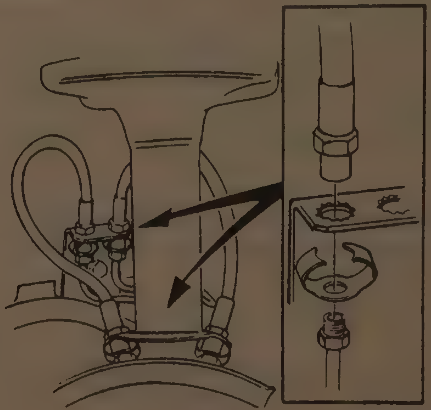

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Fig. 20 Common brake hose and connection design at the front calipers

tion, if the level in the master cylinder reservoir is allowed to go below the minimum mark for too long a period of time, air may enter the system, necessitating bleeding.

If only one brake caliper or wheel cylinder is removed for servicing, it is usually necessary to bleed only that unit. If, however, the master cylinder, warning valve, or any of the main brake lines are removed, the entire system must be bled. There is a specific sequence you should follow when bleeding the brakes of your Volvo (see drawings).

Be careful not to spill any brake fluid onto the brake surfaces (disc, pads, drum and linings) and, of course, the paint work. When bleeding the entire system, the rear of the car should be raised higher than the front. Only use brake fluid bearing the designation SAE 1703 (SAE 70 R3), or DOT 4. Never reuse old brake fluid.

➡The following procedure is acceptable for cars with and without ABS.

1. Check to make sure that there are not mats or other materials obstructing the travel of the brake pedal. During

Fig. 21 Bleed the brakes until no bubbles appear

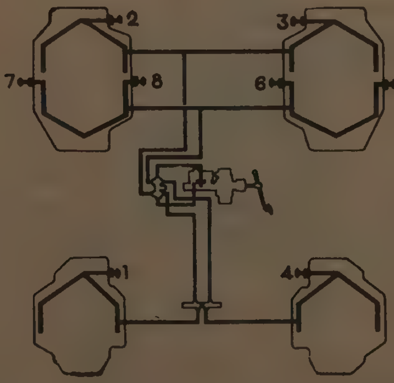


Fig. 22 Brake bleeding sequence: 140 and 164 series with Girling brakes

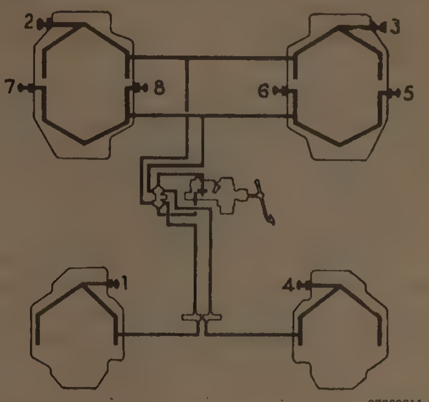


Fig. 23 Brake bleeding sequence: 140 and 164 series with ATE brakes

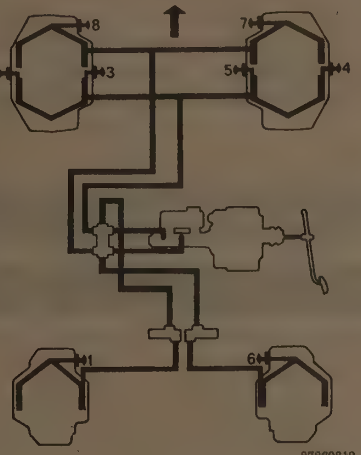


Fig. 24 Brake bleeding sequence: 1800 series (all)

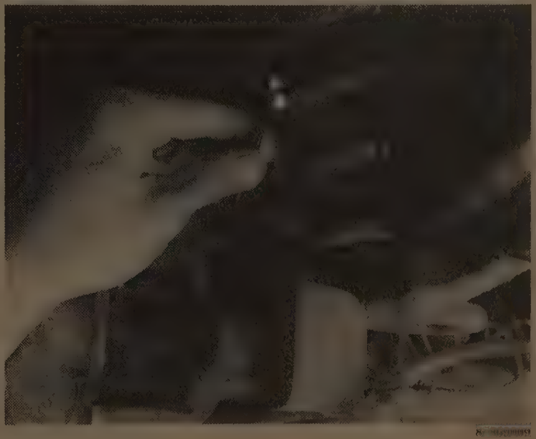


Fig. 25 Keep the tube submerged in the bottle — never reuse old brake fluid

bleeding, the full pedal travel should be 6 in. (150mm) for the 140, 240, 260 series and later models, and 5.5 in. (140mm) for the 164 and 1800 series (providing that both circuits are bled simultaneously).

2. Clean the cap and the top of the master cylinder reservoir, and make sure that the vent hole in the cap is open. Fill the reservoir to the maximum mark. Never allow the level to dip below the minimum mark during bleeding, as this will allow air into the system.

3. If only one brake caliper or line was removed, it will usually suffice to bleed only that wheel. Otherwise, prepare to bleed the entire system beginning at the left front wheel.

4. Remove the protective cap for the bleeder screw, and fit a 5/16 line wrench on the nipple. Install a tight plastic hose onto the nipple, and insert the other end of the hose into a glass bottle containing clean brake fluid. The hose must hang down below the surface of the fluid, or air will be sucked into the system when the brake pedal is released.

5. Open the bleeder screw a maximum of ½ turn. Have a helper slowly depress the brake pedal until it bottoms, pause a second or two, and then quickly release the pedal. This should be repeated until the fluid flowing into the bottle is completely free of air bubbles. During this procedure you should check the master cylinder reservoir frequently and top up the fluid level as needed. Have your helper press the pedal to the bottom of its travel and hold it there while you tighten the bleeder screw. Install the protective cap.

➡On the 240, 260 series and the 1980 and later models, when bleeding the front brakes, connect bleeder hoses to all three bleeder nipples (two on the 760 GLE), submerge the hoses in brake fluid and open the nipples. Keeping the reservoir full, pump the brake pedal until no bubbles appear, hold the pedal down and close the nipple.

6. If the entire system is to be bled, follow the above procedure for the remaining nipples at the right front, left rear and right rear wheel IN THAT ORDER. Generally, it is sufficient to bleed each circuit once. However, if the pedal continues to feel spongy, repeat the bleeding sequence. Remember to keep the master cylinder reservoir level above the minimum mark.

7. Fill the reservoir with the specified brake fluid to the maximum mark.

8. With the bleeder valves closed and the master cylinder topped off, turn the ignition ON but do not start the engine. Apply moderate force to the brake pedal simulating a hard stop. The pedal must travel no more than 2.4 in. (61mm) without ABS; 2.17 in. (55mm) with ABS. The brake warning light (and ABS light) must stay off. Switch off the ignition and continue to bleed the system until the pedal travel and/or the brake warning light tests are satisfied.

9. Top off the reservoir and install the cap. Remember to put the rubber caps onto the bleeder nipples at each caliper.

FRONT DISC BRAKES

Brake Pads

INSPECTION

The front brake pads may be inspected without removal. With the front end elevated and supported, remove the wheel(s). Unlock the steering column lock and turn the wheel so that the brake caliper is out from under the fender.

View the pads — inner and outer — through the cut-out in the center of the caliper.Remember to look at the thickness of the pad friction material (the part that actually presses on the disc) rather than the thickness of the backing plate which does not change with wear.

Remember that you are looking at the profile of the pad, not the whole thing. Brake pads can wear on a taper which may not be visible through the window. It is also not possible to check the contact surface for cracking or scoring from this position. This quick check can be helpful only as a reference; detailed inspection requires pad removal.

REMOVAL & INSTALLATION

✱✱CAUTION

Brake pads and shoes may contain asbestos, which has been determined to a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling and dust from brake surfaces! When cleaning brakes, use commercially available brake cleaning fluids.

Girling Brakes

EXCEPT 700 SERIES

➧ See Figures 26 and 27

1. Remove the hub caps and loosen the lug nuts a few turns.

2. Raise the vehicle and place jackstands beneath the rear axle and the front jack attachments. Remove the wheels.

3. Remove the hairpin-shaped locking clips together with the damping springs for the brake pads. Pull out the pads. Discard them if they are worn down to a lining thickness of ⅛ in. (3mm) or less. If they are reusable, mark them for ease of assembly.

4. Carefully clean out the pad cavity. Replace any damaged dust covers. If any dirt has contaminated the cylinders, the caliper must be removed for overhaul. Inspect the brake disc as described under Brake Discs Inspection and Replacement.

5. Carefully depress the pistons in their cylinders so that the new pads will fit. This may be done with a large pair of pliers or a C-clamp, but extra care must be exercised not to damage the rubber piston seals, the pistons, or the new pads themselves. A piston depressing tool (Volvo 2809) is available from the dealer that accomplishes the job without danger to the caliper components. Remember that when the pistons are depressed in their bores, brake fluid is displaced causing the level in the master cylinder to rise, and perhaps, overflow.

6. Install the new pads and secure them with first one lock pin, then the other pin with the damping springs. Install new locking clips on the lock pins. Make sure that the pads are able to move and that the linings do not project outside of the brake disc.

➡If the Girling calipers were fitted with plates between the brake pads and the caliper, reinstall the plates. If, instead of plates, round damper washers were used, refit them with their smaller contact face towards the pad. Never use glue or grease and do not attempt to use plates and washers at the same time. Not all Girling calipers use plates or washers.

7. Depress the brake pedal several times and make sure that the movement feels normal. The first brake pedal application may result in a very "long" pedal due to the pistons being retracted. Always make several brake applications before starting the vehicle. Bleeding is not usually necessary after pad replacement.

8. Install the wheel. Remove the jackstands and lower the vehicle. Tighten the lug nuts to 80-90 ft. lbs. (108-122 Nm) and install the hub cap.

➡Braking should be moderate for the first five miles or so until the new pads seat correctly. The new pads will bed best if put through several moderate heating and cooling cycles. Avoid hard braking until the brakes have experienced several long, slow stops with time to cool in between. Taking the time to properly bed the brakes will yield quieter operation, more efficient stopping and contribute to extended brake life.

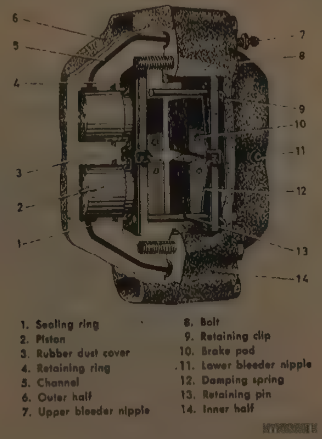


Fig. 26 Cutaway view of the Girling front caliper — all except 700 series models

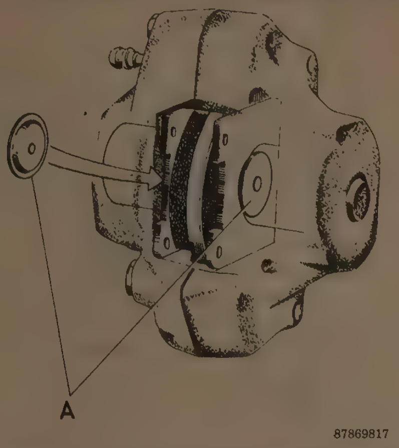


Fig. 27 Cutaway view of the rear Girling caliper fitted with round damper washers

700 SERIES

➧ See Figures 28 and 29

1. Loosen the lugs one or two turns, raise the vehicle and place on jackstands.
2. Remove the wheels.
3. Remove the bolt in the lower guide pin and loosen the upper bolt a few turns. Hold the guide pin with a 17mm wrench.
4. Lift up the caliper and remove the brake pads.

WARNING

Do not depress the brake pedal when the caliper is removed.

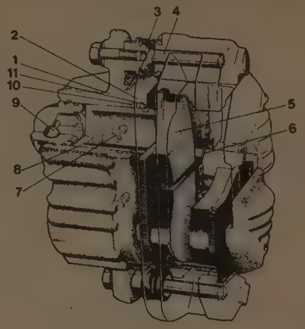
5. Carefully clean out the pad cavity. Replace any damaged parts. If any dirt has contaminated the cylinders, the caliper must be removed for overhaul. Inspect the brake disc as described under Brake Discs Inspection and Replacement.
6. Carefully depress the pistons in their cylinders with pliers. Be careful not to damage the dust covers.

➡Remove some brake fluid when depressing pistons or brake fluid reservoir may overflow.

7. Check the condition of the boots on the guide pins and replace them if they are cracked or broken. Check the guide pins; clean them with solvent (never with sandpaper or a wire brush) and coat them with a silicone high-temperature grease.

To install:

8. Install the new brake pads and reposition the caliper. Always use a new bolt and made sure that the springs on the brake pads are correctly positioned. Tighten the bolt in the lower guide pin to 25 ft. lbs. (34 Nm).
9. Depress the brake pedal several times and make sure that the movement feels normal. The first brake pedal application may result in a very "long" pedal due to the pistons being retracted. Always make several brake applications before starting the vehicle. Bleeding is not usually necessary after pad replacement.



1. Caliper
2. Holder
3. Rubber bellows
4. Guide pin
5. Brake lining
6. Spring
7. Bleeder screw
8. Piston
9. Brake fluid inlet
10. Sealing ring
11. Dust cover

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Fig. 28 Cutaway view of the Girling front caliper — 700 series models

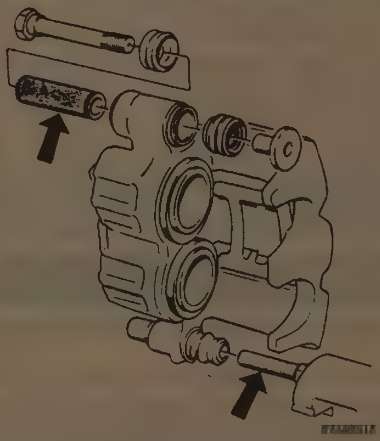

Fig. 29 Arrows indicate the slide points to be lubricated — 700 series front calipers

10. Install the wheel. Remove the jackstands and lower the vehicle. Tighten the lug nuts to 60 ft. lbs. (81 Nm) and install the hub cap.

➡Braking should be moderate for the first 5 miles (8 km) or so until the new pads seat correctly. The new pads will bed best if put through several moderate heating and cooling cycles. Avoid hard braking until the brakes have experienced several long, slow stops with time to cool in between. Taking the time to properly bed the brakes will yield quieter operation, more efficient stopping and contribute to extended brake life.

ATE Brakes

➧ See Figure 30

1. Remove the hub caps and loosen the lug nuts a few turns.
2. Raise the vehicle and place jack stands beneath the rear axle and the front jack attachments.
3. Using a 9/16 in. drift, tap out the upper guide pin for the pads, remove and discard the tensioning spring. Tap out the lower pin. Pull out the pads and inspect them. Discard them if they are worn down to a lining thickness of 1/8 in. (3mm) or less. If they are reusable, mark them for ease of assembly.
4. Carefully clean out the pad cavities. Replace any damaged dust covers. If any dirt has contaminated the cylinders, the caliper must be removed for overhaul. Inspect the brake disc as described under Brake Disc Inspection and Replacement.
5. Carefully depress the pistons in their cylinders so that the new pads will fit. This may be done with a large pair of pliers or a C-clamp, but extra care must be exercised not to damage the rubber piston seals, the pistons, or the new pads themselves. A piston depressing tool (Volvo 2809) is available from the dealer that accomplishes the job without danger to the caliper components. Remember that when the pistons are depressed in their bores, brake fluid is displaced, causing the level in the master cylinder to rise, and perhaps, overflow.
6. Install the new pads. Using only a hammer, tap one of the guide pins into position. Place a new tensioning spring into position, and while pushing it in against the pads tap the other guide pin into position. Make sure that the pads can move.
7. Depress the brake pedal several times and make sure that the movement feels normal. The first brake pedal application may result in a very "long" pedal due to the pistons being retracted. Always make several brake applications before starting the vehicle. Bleeding is not usually necessary after pad replacement.
8. Install the wheel. Remove the jackstands and lower the vehicle. Tighten the lug nuts to 80-90 ft. lbs. (108-122 Nm) and install the hub cap.

➡Braking should be moderate for the first 5 miles (8 km) or so until the new pads seat correctly. The new pads will bed best if put through several moderate heating and cooling cycles. Avoid hard braking until the brakes have experienced several long, slow stops with time to cool in between. Taking the time to properly bed the brakes will yield quieter operation, more efficient stopping and contribute to extended brake life.

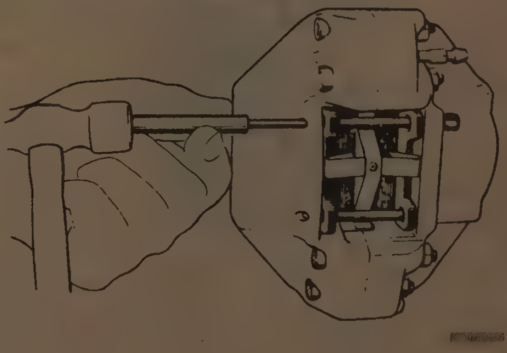

Fig. 30 Remove the guide pins with a hammer and 9/16 in. drift — ATE brakes

Brake Caliper

REMOVAL & INSTALLATION

➧ See Figure 31

1. Loosen the lug nuts a few turns. Block the reservoir cap vent hole to reduce leakage of brake fluid when the lines are disconnected. Firmly apply the parking brake.
2. Raise the front end and place jackstands beneath the front jack attachments. Remove the wheel.
3. On 140 series and 164 models, remove the brake hose retaining clip from the stabilizer bar and disconnect the lower hose and brake line from their connection underneath the car. Disconnect the upper hose from the caliper. Plug all brake connections to prevent leakage.
4. On 1800, 200 and 700 Series, label and disconnect the brake lines at the caliper and plug them.
5. Remove the two caliper attaching bolts and lift the unit off the retainer.
6. To install, first check the mating surfaces of the caliper and its retainer to make sure that they are clean and not damaged. Always use new retaining bolts and lightly coat the threads with a locking compound. Position the caliper to its retainer over the disc and install the two attaching bolts. For all vehicles except 700 Series, tighten the bolts to 65-70 ft. lbs. (88-95 Nm). The mounting bolts on 700 Series cars should be tightened only to 25 ft. lbs. (34 Nm). Install the brake pads (if not already done), making sure that the caliper is parallel to the disc and that the disc can rotate freely in the brake pads.
7. On 140 series and 164 models, connect the lower brake hose and the brake line to their inboard connection and install the brake hose retaining clip to the stabilizer bar. Connect the upper brake hose to the caliper.
8. On 1800, 240, 260 and 700 Series, connect both brake lines to the caliper.
9. Unplug the reservoir cap vent hole. Install the wheel and lower the car to the ground. Tighten the lug nuts to 80-90 ft. lbs. (108-122 Nm).
10. Bleed the brake system as outlined in this section.

OVERHAUL

➧ See Figures 32, 33, 34, 35, 36 and 37

➡The following procedure applies to front and rear calipers of both Girling and ATE design.

1. Remove the brake caliper and pads from the car.
2. Remove the retaining rings and the rubber dust covers. Place a wooden block between the pistons. Using compressed air applied through the brake line port, force the pistons toward the wooden block. Remove the pistons from their bores, taking care not to burr or scratch them.

➡Compressed air is the only reliable way to force out the pistons. Do not attempt to lever or pry out the pistons. The metal will become gouged and function will be impaired.

3. Remove the sealing rings with a blunt plastic tool. Be careful not to damage the edges of the grooves. Screw out the bleeder nipple(s), and on front calipers, remove the external connecting line if still attached.

✲✲WARNING

Do not attempt to separate the caliper halves. Assembling the halves requires special pressure testing equipment. Overhaul can be completed without splitting the caliper.

4. Clean all reusable metal parts in clean brake fluid or methylated alcohol. Dry all parts with compressed air or allow to air dry. Make sure that all of the passages are clear. All alcohol must be removed from the parts. If any of the cylinders are scored or scratched, the entire housing must be replaced. Minor scratching may be removed from the pistons by fine polishing. Replace any piston that is damaged or worn.
5. Coat the mating surfaces of the pistons and cylinder with fresh brake fluid.
6. Install new sealing rings in the cylinders.

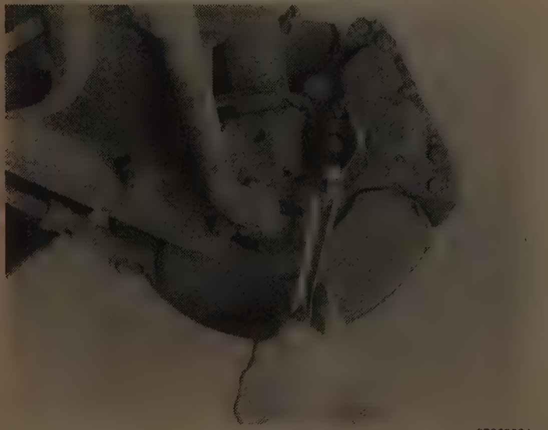

Fig. 31 With the pads removed, remove the bolts, then disconnect the brake line and the caliper

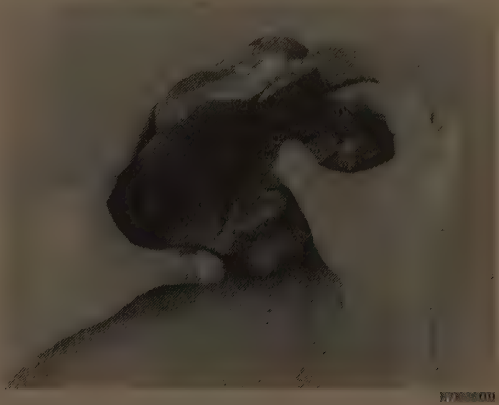

Fig. 32 Remove the retaining rings and the rubber dust covers from the pistons — front 4-piston caliper shown; the procedure is common to all Volvo calipers

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Fig. 33 With a wooden block installed, use compressed air to force the pistons out of their bores

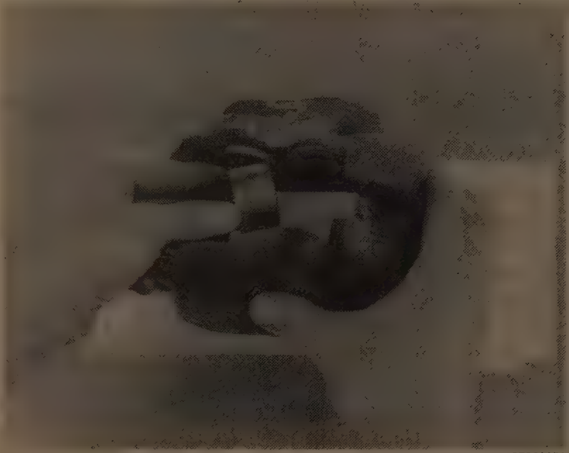
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Fig. 34 Remove the pistons for inspection

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Fig. 35 Remove the seals with a small prytool

7. On Girling brakes and ATE front brakes, press the pistons into their bores with the large end facing inward. Make sure that the pistons are installed straight and are not scratched in the process.

8. On ATE rear brakes, make sure that the pistons are in the proper positions to prevent brake squeal. The piston notches should incline 20° in relation to the lower guide area on the caliper. Check the location of the piston with a template such as Volvo tool 2919. When the template is placed against the one recess, the distance (A) to the other recess may be no greater then 0.039 in. (1mm). If the location of the piston needs adjusting, use Volvo tool 2918 or similar and press it against the piston. Force out the shoes by screwing in the handle. Turn the piston in the required direction, release the tool and remeasure with the template. Repeat this operation for the other piston.

9. Place the new rubber dust covers on the pistons and housing. Install the new retaining rings.

10. Screw in the bleeder nipples(s).

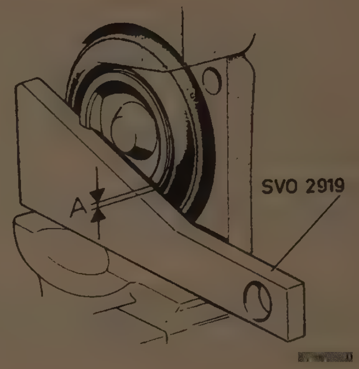

Fig. 36 Check that the ATE rear caliper pistons are located within specification — special Volvo tool shown

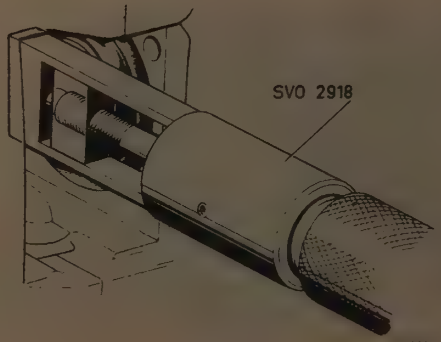

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Fig. 37 Adjust the ATE rear caliper pistons to the proper tolerance

11. Install the assembled caliper, then install the brake pads. Connect the brake line(s).
12. Add brake fluid to the reservoir to replace that lost during removal. Bleed the brake system.

Brake Disc (Rotor)

➧ See Figure 38

REMOVAL & INSTALLATION

Except 700 Series

➧ See Figures 39, 40, 41, 42, 43, 44, 45, 46 and 47

1. Loosen the lug nuts a few turns. Elevate the car and safely support on jackstands.
2. Remove the wheel.
3. Remove the brake pads and remove the brake caliper. Do not disconnect the brake hose running to the caliper; use a piece of stiff wire and hang the caliper out of the way.
4. Loosen and remove the small retaining screws on the face of the disc. They will be difficult to loosen; don't strip the heads.
5. Remove the brake disc. It may be necessary to tap on the disc with a rubber or rawhide mallet to loosen it from its place. Don't use a metal hammer; you can crack the disc.
6. When reassembling, make sure the disc sits squarely on the mount and install the retaining screws.
7. Install the brake caliper and pads. Check that the disc can turn freely and that the caliper is properly seated. Since the brake line was not disconnected, it should not be necessary to bleed the brakes.
8. Reinstall the wheel and lower the car to the ground. Final tighten the lug nuts to 80-90 ft. lbs. (108-122 Nm).

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Fig. 38 Periodically inspect the brake system to ensure adequate pad and rotor thickness — these are considered normal wear items

87869015

Fig. 39 Raise and properly support the vehicle before working under it

700 Series

➧ See Figure 48

1. Loosen the lug nuts a few turns. Elevate the car and safely support on jackstands.
2. Remove the wheel.
3. Remove the brake pads and remove the brake caliper. Do not disconnect the brake hose running to the caliper; use a piece of stiff wire and hang the caliper out of the way.
4. Use a 10mm Allen wrench to disconnect the caliper bracket.
5. Remove the center grease cap, the cotter pin and the castle nut.
6. Remove the outer wheel bearing and place in a clean, protected location.
7. Remove the brake disc and the inner wheel bearing. It may be necessary to use a bearing puller (Volvo 2722 or similar) if the inner bearing is difficult to remove. Place the bearing in a clean, protected location. Remove the inner bearing seal if it remains in the hub.

➡Cars with ABS have the pulse wheel mounted within the disc. This toothed wheel must be removed and transferred to a new rotor if one is being installed. Use a universal gear puller and carefully lift off the pulse wheel. Use a bearing installation tool and a press to install the pulse wheel on the new disc.

8. When reassembling, the wheel bearings must be cleaned and repacked. The reader is referred to the Front Wheel Bearings — 700 Series portion of Section 8.
9. Install the inner bearing in the hub. Using a seal installation tool, install a new grease seal. Make sure the face of the seal is even with the hub.
10. Install the brake disc, the outer bearing and the castle nut. Rotate the disc while tightening the nut to 41 ft. lbs. (55 Nm). Loosen the nut 1/2 turn.
11. Tighten (finger tight) the nut to 13 inch lbs. (1.5 Nm) and install a new cotter pin. If the cotter pin will not go through the nut into the hole, tighten the nut slightly.
12. Install the brake caliper. Use new attaching bolts and tighten them to 72 ft. lbs. (97 Nm).
13. Install the brake pads.
14. Install the wheel and lower the vehicle to the ground. Final tighten the wheel lugs to 60 ft. lbs. (81 Nm).

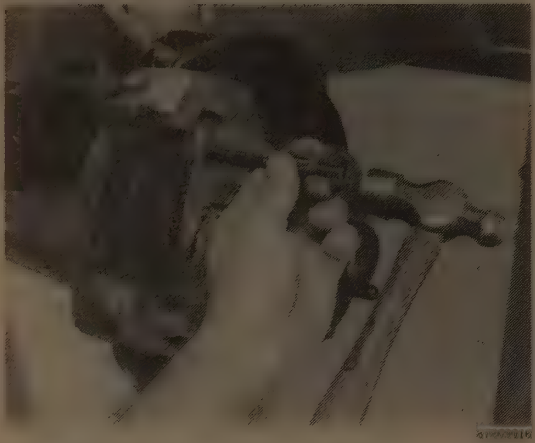


Fig. 40 If equipped with retaining pins, drive them out with a hammer and drift

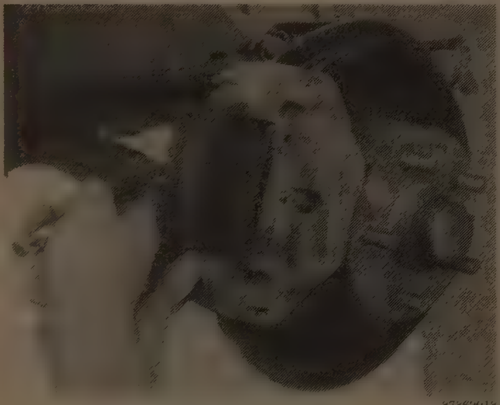


Fig. 41 With pliers, grasp and pull out the pad from its mounting position — it may be necessary to pry the pad to gain clearance from the disc

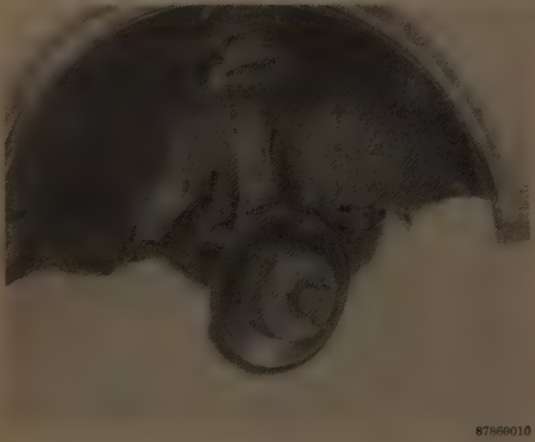


Fig. 42 Use a piece of stiff wire and hang the caliper out of the way

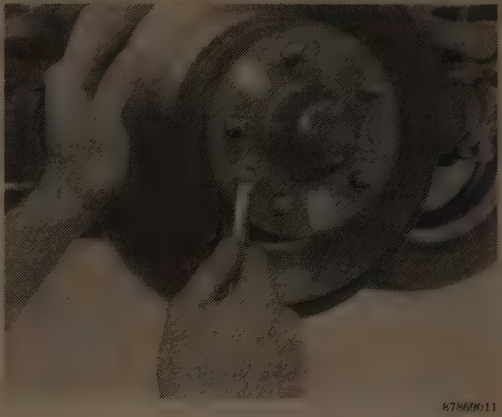


Fig. 43 Remove the disc retaining screws — if resistance is high, stop and apply a penetrating lubricant to loosen them for a few minutes

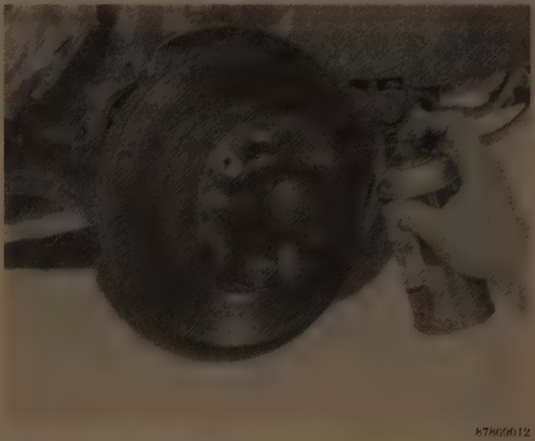


Fig. 44 If needed, apply penetrating lubricant to the mounted disc to ease removal

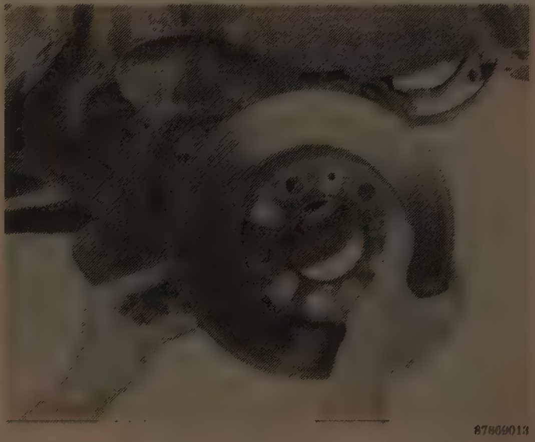


Fig. 45 Remove the disc — if necessary, use a soft faced hammer to lightly tap it free

Fig. 46 Separate the backing plate from the pad — do not forget to reinstall it later

Fig. 47 To provide clearance for the new (thicker) pads, press the pistons into the caliper. This causes brake fluid to flow back to the master cylinder

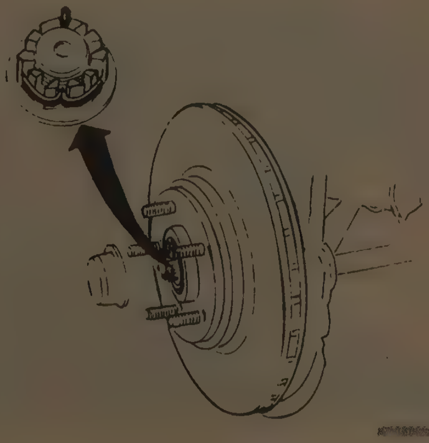


Fig. 48 Always use a new cotter pin when installing the disc — bend the ends as shown

INSPECTION

▶ **See Figure 49**

The brake disc may be inspected without removal, however viewing the back (inner) face of the disc is difficult. Ideally, the caliper should be removed allowing full access to both faces of the disc. Run-out measurements must be taken with the disc mounted on the car and the wheel bearings properly adjusted.

The friction surface on both sides of the disc should be examined for surface deviations such as scoring or corrosion. Minor radial scratches and small rust spots may be removed by resurfacing or fine polishing the disc. The lateral run-out of the disc must not exceed 0.004 in. (0.1mm) for the front, and 0.060 in. (0.15mm) for the rear, measured at the outer edge of the disc. Do not mistake a faulty wheel bearing adjustment, or an improperly mounted disc for lateral run-out.

Actual disc thickness, which varies from model to model (see specifications), should not vary more than 0.0012 in. (0.03mm) when taken at several points on the same disc. If the disc is worn at any point to less than the minimum permissible thickness (see specifications), it must be replaced. A brake disc which is too thin cannot handle the heat generated by braking. If the disc cracks under braking, the wheel can lock instantly, causing loss of control and a possible collision.

After the disc has been resurfaced, measure the thickness to insure it is still above the minimum specification. A resurfaced disc should be washed in solvent inside and out to remove any metal filings which could get caught in the wheel bearings. Dry the disc thoroughly and repack the wheel bearings and inner hub. A new set of brake pads is highly recommended when installing a new or reconditioned disc.

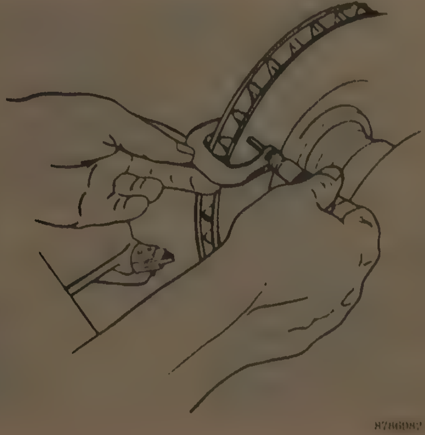


Fig. 49 Use a micrometer to measure the brake disc thickness

REAR DISC BRAKES

Brake Pads

INSPECTION

See Figure 50

The rear brake pads may be inspected without removal. With the rear end elevated and supported and the front wheels blocked, remove the wheel(s). View the pads — inner and outer — through the cut-out in the center of the caliper. Remember to look at the thickness of the pad friction material (the part that actually presses on the disc) rather than the thickness of the backing plate which does not change with wear.

Remember that you are looking at the profile of the pad, not the whole thing. Brake pads can wear on a taper which may not be visible through the window. It is also not possible to check the contact surface for cracking or scoring from this position. This quick check can be helpful only as a reference; detailed inspection requires pad removal.

REMOVAL & INSTALLATION

See Figures 51, 52 and 53

****CAUTION**

Brake pads and shoes may contain asbestos, which has been determined to a cancer causing agent. Never clean the brake surfaces with compressed air! Avoid inhaling and dust from brake surfaces! When cleaning brakes, use commercially available brake cleaning fluids.

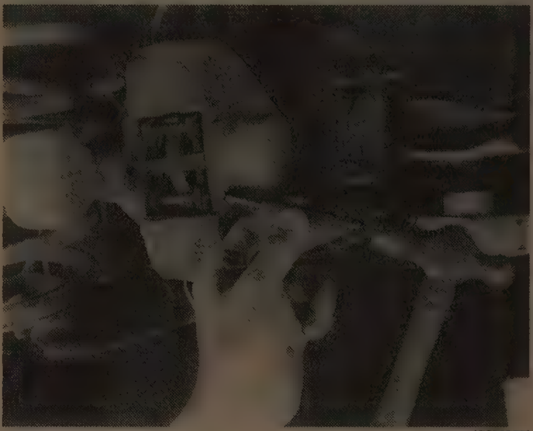


Fig. 51 Use a hammer and drift to drive out the brake pad retaining pin from the rear caliper

The rear brake pads for all models are removed following the same procedures as the front pads. Identify the type of caliper — ATE or Girling — and refer to the instructions for front brake pad removal earlier in this section.

In 1988, with the introduction of the Multi-Link rear suspension, Volvo redesigned the rear caliper and disc on certain 700 Series cars. The rear caliper is virtually identical to the front caliper, but before the rear caliper can be swung up (on its upper pivot), it may be necessary to push the piston back. Do this by inserting a small prytool into the recess between the outer pad and the caliper and gently moving the caliper. Remember that doing this may cause the brake fluid reservoir to overflow.

Reinstall the pads following the directions given earlier under Front Disc Brakes — Removal and Installation. Remember that the rear brakes must also be bedded in the first few miles of driving.

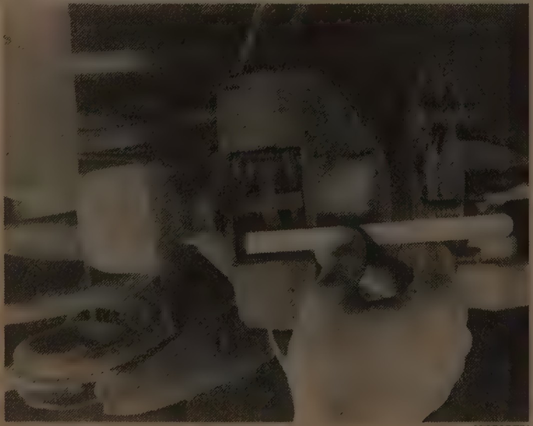


Fig. 50 Use a ruler for more precise gauging of pad wear

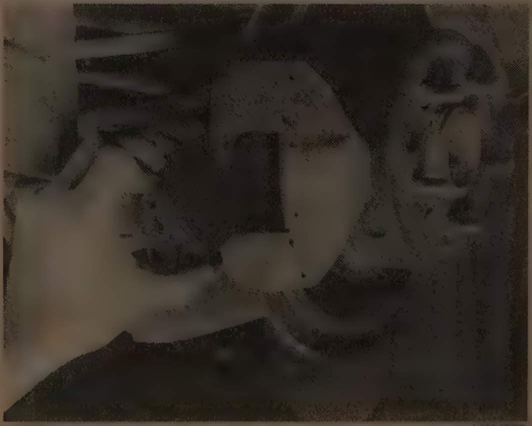


Fig. 52 After removing the pins, remove the anti-rattle spring clip and the pads

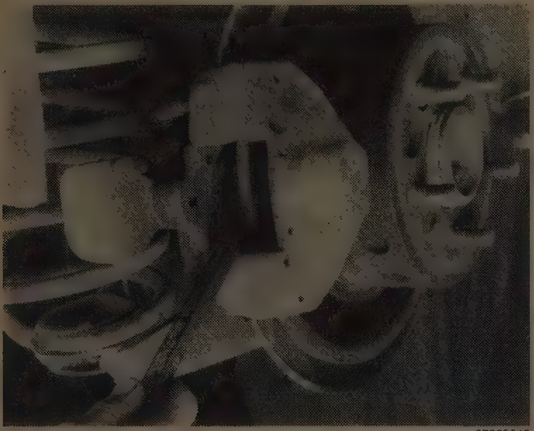


Fig. 53 Pry the piston back into the caliper to provide clearance for the new (thicker) pads

Fig. 54 Remove the pads, then unbolt and remove the caliper from its carrier

Brake Caliper

REMOVAL & INSTALLATION

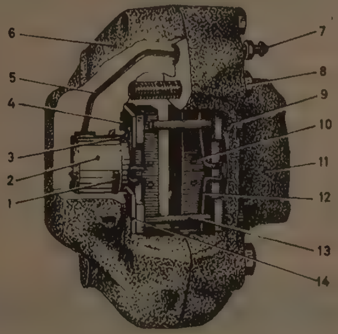
➧ See Figures 54, 55 and 56

1. Loosen the lug nuts a few turns. Block the reservoir cap vent to reduce fluid loss.
2. Place blocks in front of the front wheels. Raise the rear of the car and place jackstands beneath the rear axle. Release the parking brake and remove the wheel(s).
3. Some vehicles have a protective cover over the caliper. It is easily removed by loosening its mounting bolt. Disconnect the brake line at the joint near the shock absorber or inner fender well (not at the caliper). Plug the line.
4. Remove the brake pads. Remove the two caliper attaching bolts and lift the caliper off the retainer. The brake hose may now be removed from the caliper.

To install:

5. First check the mating surfaces of the caliper and its retainer to make sure that they are clean and not damaged. Coat the threads of the attaching bolts with locking compound. Attach the brake hose to the caliper and position the caliper to its retainer. Install two new attaching bolts. Tighten the bolts to 42 ft. lbs. (57 Nm). Make sure that the caliper is parallel to the disc, and that the disc can rotate freely in the brake pads. If the protective cover was removed, replace it.
6. Connect the brake hose to the system. Unplug the reservoir cap hole.
7. Install the wheel. Remove the jackstands and lower the car. Tighten the lug nuts on all models except 700 series to 80-90 ft. lbs. (108-122 Nm). For 700 series, tighten them to 63 ft. lbs. (85 Nm).
8. Bleed the rear brake caliper as outlined in this section.

➡Once the calipers have been removed, they may be overhauled following the procedures given earlier in this section.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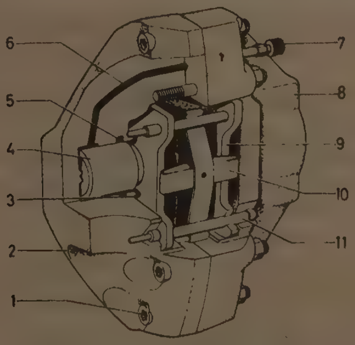
1. Sealing ring
2. Piston
3. Rubber dust cover
4. Retaining ring
5. Channel
6. Outer half
7. Bleeder nipple
8. Bolt
9. Retaining clip
10. Brake pad
11. Inner half
12. Damping spring
13. Retaining pin
14. Washer
87869818

Fig. 55 Cutaway view of the Girling rear caliper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1. Bolt
2. Outer half
3. Rubber dust cover
4. Piston
5. Sealing ring
6. Channel
7. Bleeder nipple
8. Inner half
9. Brake pad
10. Damping spring
11. Guide pin

Fig. 56 Cutaway view of the ATE rear caliper

Brake Disc (Rotor)

REMOVAL & INSTALLATION

▶ See Figure 57

The rear discs are removed in the same manner as the front discs. After removing the wheel, brake pads and caliper, hang the caliper out of the way. The disc will have the small retaining screws on the face; loosen them and the disc will come free.

Late model 700 Series with Multi-Link rear suspension have a small stud threaded into the disc. While helping to locate the wheel, this stud also retains the disc to the hub. Loosen it and the disc comes free. Note that it is NOT necessary to loosen the large center hub nut to remove the disc. Please don't.

Although the outer part of the rear disc serves as the contact surface for the hydraulic (foot) brakes, the inner surface is the contact surface for the cable operated emergency/parking brake. If you plan to have the discs re-faced, also check the condition of the inner face. It generally stays in good shape, but can become scored from dust and grit. The maximum allowable diameter for this drum is 6.32 in. (16cm). Diameters in excess of this measurement require discarding the disc.

PARKING BRAKE

The cable operated parking (or sometimes called "emergency") brake is a complete separate brake system acting only on the rear wheels. When the lever in the car is pulled up, cables running to the rear of the car actuate 2 sets of brake shoes. These shoes expand against the machined surface inside the rear brake disc. Thus, the car still has (limited) stopping ability even if the entire hydraulic brake system fails.

Because of the many advances in design and engineering, and the government regulations requiring dual hydraulic brake systems, the odds of a total hydraulic failure are probably longer than your chances of hitting the lottery in three states on your birthday. The system must, however, remain in proper repair and adjustment so that it will hold the car when parked and be available for emergency use if needed.

Cables

▶ See Figure 58

ADJUSTMENT

1800, 140 and 160 Series

▶ See Figures 59, 60 and 61

The parking brake should be fully engaged when the lever is pulled up to the third or fourth notch. If it is not, adjust as follows:

1. Apply the parking brake. Remove the rear hub caps and loosen the lug nuts a few turns.
2. Place blocks in front of the front wheels. Jack up the rear end and place jackstands beneath the rear axle. Remove the wheel. Release the parking brake.
3. Make sure that the brake pads are not stuck on the discs. Disconnect the parking brake cable from the actuating lever. This keeps the pre-tension off the brakes while you adjust them.
4. Rotate the disc until the adjusting screw hole aligns with the serrations (ridges) on the adjusting wheel inside the disc. Insert a screwdriver, and adjust the shoes by moving the handle of the screwdriver upward. When the disc cannot be rotated easily, stop adjusting the shoes. Turn the adjusting screw back 4 or 5 serrations. Turn the disc in its normal direction of rotation and make sure that the shoes do not drag. A slight brushing is permissible, but if there is heavy drag, back off the adjusting screw 2 or 3 serrations more. Connect the cable to the lever.
5. Repeat the adjusting procedure for the other wheel.
6. Apply the parking brake lever and make sure that the parking brake is fully engaged with the lever at the third or fourth notch. If the brakes are properly adjusted but don't apply fully, adjust the cable:
    a. Locate the cable yoke assembly under the car. It is the device that pulls simultaneously on both the left and right brake cables.
    b. Loosen the two locknuts on the threaded shaft. The shaft will probably be dirty and rusted. Be prepared to clean the threads.
    c. Tighten the adjusting nut (the one that bears on the spring) a few turns and recheck the lever in the car. Continue adjusting until the brakes are fully applied at the third or fourth notch.
    d. Tighten both locknuts. While you're under there, clean the pulley wheel and apply a light coat of oil to its axle.

➡Do not attempt to adjust the parking brake only by tightening the cable. The brake shoes must be properly adjusted before the cable is tightened.

7. Install the wheels. Remove the jackstands and lower the car. Tighten the lug nuts to 80-90 ft. lbs. (108-122 Nm).

200 Series

1. Apply the parking brake. Remove the rear hub caps and loosen the lug nuts a few turns.
2. Place blocks in front of the front wheels. Jack up the rear end and place jackstands beneath the rear axle. Remove the wheel. Release the parking brake.
3. Make sure that the brake pads are not stuck on the discs.
4. Rotate the disc until the adjusting screw hole aligns with the serrations (ridges) on the adjusting wheel inside the disc. Insert a screwdriver and adjust the shoes by moving the handle of the screwdriver upward. When the disc cannot be rotated easily, stop adjusting the shoes. Turn the adjusting screw back 4 or 5 serrations. Turn the disc in its normal direction of rotation and make sure that the shoes do not drag. A slight brushing is permissible, but if there is heavy drag, back off the adjusting screw two or three serrations more.
5. Repeat the adjusting procedure for the other wheel.

Fig. 57 Remove the caliper, the small retaining screws, then the disc

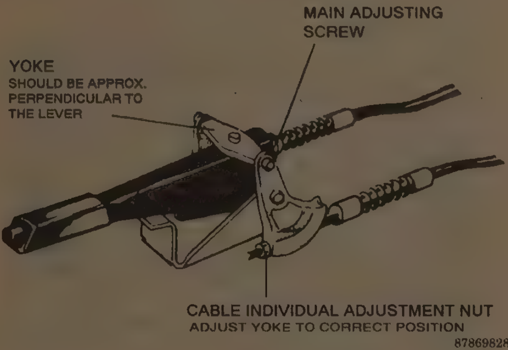
MAIN ADJUSTING SCREW
YOKE
SHOULD BE APPROX. PERPENDICULAR TO THE LEVER
CABLE INDIVIDUAL ADJUSTMENT NUT
ADJUST YOKE TO CORRECT POSITION
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Fig. 58 Brake lever assembly — a dual cable system is used to actuate the (dedicated) right and left rear parking brake shoes

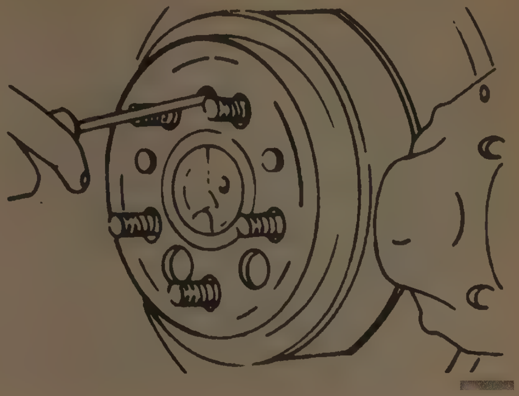
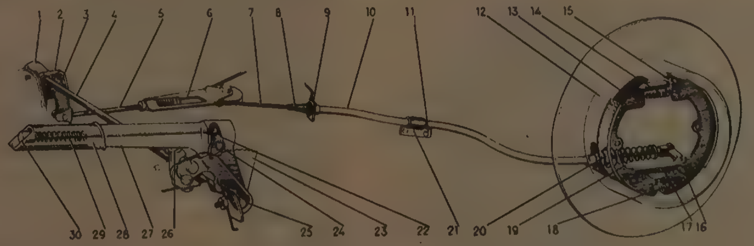


Fig. 60 Adjust the parking brake through the access hole in the rear hub

6. Apply the parking brake lever and make sure that the parking brake is fully engaged with the lever at the second and eighth notch. If the brakes are properly adjusted but don't apply fully, adjust the cable:
    a. Remove the rear ashtray at the rear of the console to gain access to the cable adjuster.
    b. Use a 17mm socket with an extension to turn the nut on the adjuster. Tighten the adjuster a few turns and recheck the adjuster in the car. Continue adjusting until the brakes are firmly applied between the second and eighth notch.
    c. Reinstall the rear ashtray.

➡Do not attempt to adjust the parking brake only by tightening the cable. The brake shoes must be properly adjusted before the cable is tightened.

7. Install the wheels. Remove the jackstands and lower the car. Tighten the lug nuts to 80-90 ft. lbs. (108-122 Nm).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1. Inside support attachment
2. Rubber cover
3. Lever
4. Shaft
5. Pull rod
6. Block
7. Cable
8. Rubber cover
9. Front attachment
10. Cable sleeve
11. Attachment
12. Brake drum
13. Brake shoe (secondary shoe)
14. Return spring
15. Adjusting device
16. Lever
17. Movable rod
18. Anchor bolt
19. Return spring
20. Rear attachment
21. Rubber cable guide
22. Pawl
23. Ratchet segment
24. Rivet
25. Outside support attachment
26. Warning valve switch
27. Push rod
28. Parking brake lever
29. Spring
30. Push button

Fig. 59 Parking brake components found on all 1970-74 models

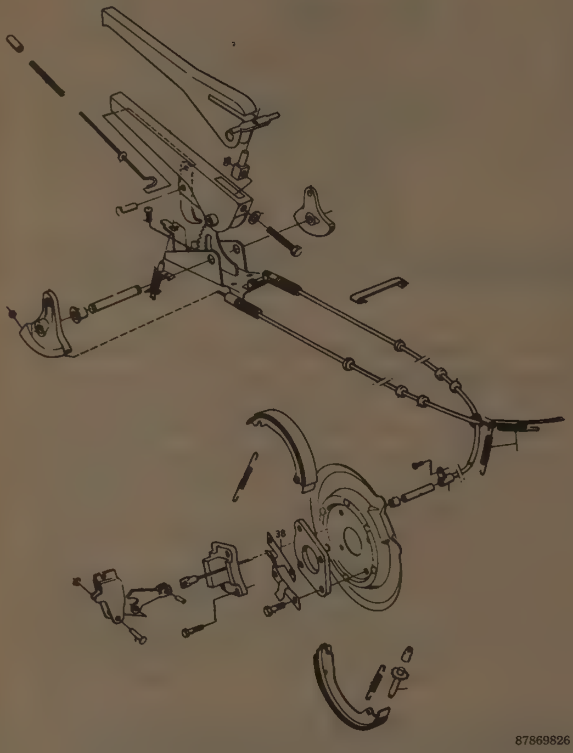

Fig. 61 Exploded view of the parking brake assembly — 1975 and later models

700 Series

1. Remove the ashtray and holder from the rear of the handbrake cover.
2. Use a screwdriver and hammer to tap the spring sleeve clear of the adjusting screw.
3. Hold the end of the threaded shaft with a pair of pliers; use an open end wrench to adjust the nut a few turns. Check the brake lever and continue to adjust until brake application is achieved between the second and fifth notches.

➡The system is designed so that the first two notches DO NOT activate the brakes. Don't overtighten the cable.

4. Check that the spring sleeve is in its original position and reinstall the ashtray and holder.

REMOVAL & INSTALLATION

1800, 140 and 160 Series

1. Apply the parking brake and loosen the rear wheel lugs a few turns.
2. Safely elevate and support the rear of the vehicle and block the front wheels. Remove the rear wheels.
3. Under the center of the car, loosen the locknuts on the adjusting yoke and loosen the brake adjustment. This relieves some of the tension from the cables.
4. Remove the bolt which is the axle for the pivot (pulley) wheel.

✻✻CAUTION

Although the tension has been lessened, the yoke and cables may spring free suddenly!

5. Working your way from the front to the rear of each side, remove the rubber boot and retaining nut at the frontmost cable mount and remove the carrier bracket farther back on the frame member.
6. At each rear wheel, compress the spring to relive tension on the arm (Volvo tool 2742 or similar) and remove the lock pin holding the cable to the brake arm. Some cars may have a locking device over the pin; pry it up to gain access.
7. Remove the return spring with the washers. Loosen the retaining nut holding the cable casing to the mount. When both sides are free, remove the cable to the front of the car.
8. Before installing the new cable, properly adjust the shoes at the rear wheels as outlined previously. Install the carriers onto the new cable.
9. Attach the cable to the rear mount and tighten the retaining nut. Do this on each side.
10. Install the spring and washers. Compress the spring and install the lock pin which holds the cable to the brake arm. The lock pin should be lightly oiled before installation.
11. Working towards the front of the car, install the carriers onto the frame member and install the front mount and rubber boot. The boots must be properly seated to keep dirt and water out of the cable casing.
12. Clean and lubricate the pulley wheel and its center pin. Catch the cable on the wheel and install the wheel into the adjusting yoke. Install the center bolt and nut.
13. Adjust the yoke as described previously in this section.
14. Refit the wheels, lower the car to the ground and final tighten the lugs to 80-90 ft. lbs. (108-122 Nm).

200 Series

➧ See Figures 62, 63, 64, 65, 66 and 67

1. Remove the console covering the parking brake lever assembly. Loosen the adjusting screw to relieve tension on the cables.

➡The brake cables cross under the car. The cable to the left rear wheel is on the right side of the lever and vice-versa. Know which cable you're changing before proceeding.

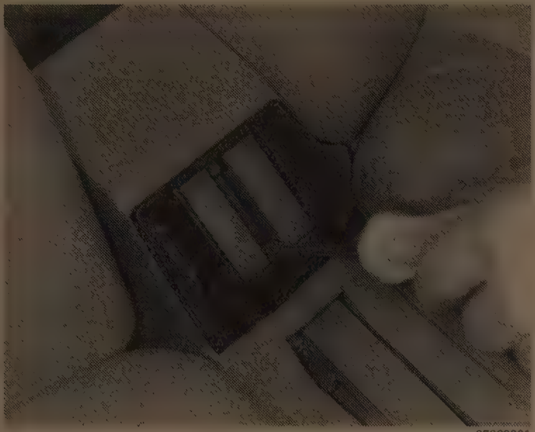

Fig. 62 Remove the center console to access the parking brake assembly

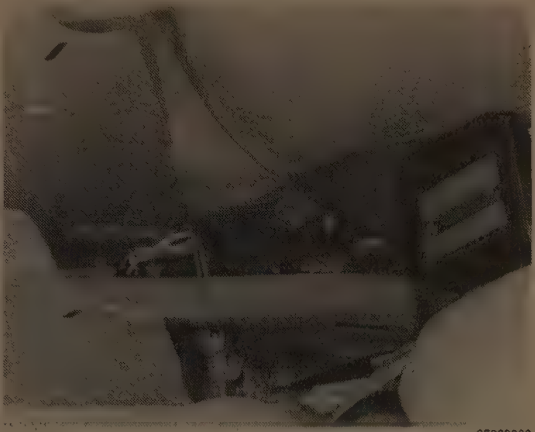

Fig. 64 With the console removed, you can adjust the parking brake (and/or remove the lever, if necessary)

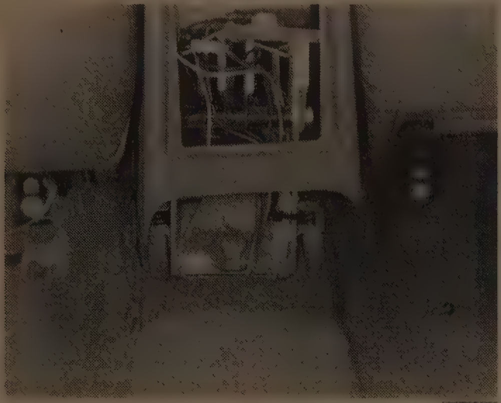

Fig. 63 The rear of the console houses the pivot point for the parking brake lever — note the cables routed under the carpet

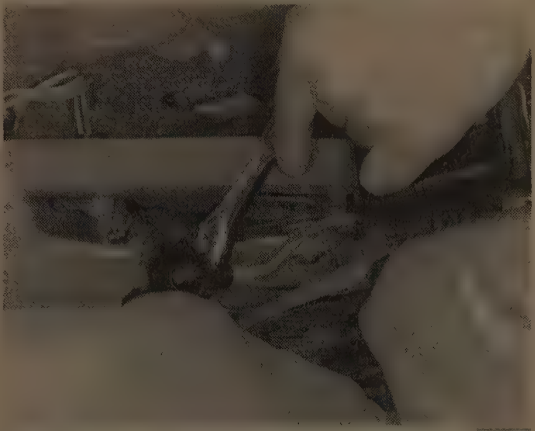

Fig. 65 Use a socket to turn the parking brake cable adjusting mechanism

2. Remove the retaining nut for the cable to be changed; it may be necessary to use a small screwdriver to keep the cable from turning.
3. Lift up the front of the rear seat cushion. Move the carpet aside and remove the clamps holding the cable to the floor. Pop the rubber grommet out of the floor pan.
4. Loosen the lugs a few turns; safely elevate and support the rear of the car. Remove the rear wheels.
5. If the vehicle has guard plates over the rear calipers, remove them.
6. Remove the clamp holding the brake line to the rear axle.
7. Remove the caliper mounting bolts and remove the caliper; use a stiff wire to hang the caliper out of the way.

****WARNING**

Be careful! The brake line is still attached to the caliper — don't bend it!

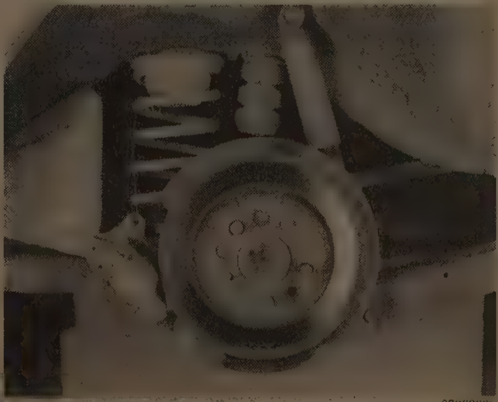

Fig. 66 Use a stiff wire (such as a coat hanger) to suspend the caliper out of the way and prevent pulling on the brake hose

8. Remove the brake disc. The hub is between you and the brake shoes, but you can work around it. Don't attempt to remove the hub.
9. Use a pair of brake spring pliers and remove the retaining spring. Remove the brake shoes; take note of the placement of the adjuster.
10. Press out the lock pin that holds the cable to the lever.
11. Under the car, just ahead of the spring, remove the retaining bolt holding the cable mount to the car. Withdraw the cable and plastic collar. Pull out the complete cable from the center support and the floor pan.
12. Install the new cable by inserting the plastic collar through bracket. Fit the rubber seal at the brake backing plate.
13. Route the cable through the center support and through the hole in the floor panel.

➡Remember that the cables cross each other. The left side cable should go through the hole on the right of the driveshaft and vice versa. Additionally, the cable from the left rear wheel should cross UNDER the right side cable at the center support.

14. Install the cable into the plastic collar and attach the retaining nut.
15. Lubricate the lock pin and the moving parts of the mechanism at each wheel. Attach the cable and install the lock pin. If the pin has a locking device, bend it back into position.
16. Install the brake shoes with the lower attaching spring. Once in place, install the adjuster and the upper attaching spring.
17. Install the brake disc. Make sure it turns freely without dragging on the brake shoes. Adjust the shoes if needed.
18. Carefully position and secure the brake caliper. Attach the clamp which holds the brake line to the rear axle.
19. Refit the caliper guard if so equipped.
20. Adjust the shoes as outlined in this section.
21. Install the rubber grommet in the floor pan. Make sure it is properly seated.
22. Place the end of the cable into the lever assembly. Install the clamp holding the cable to the floor and replace the carpet and rear seat cushion.
23. At the lever assembly, screw in the nut until the end of the cable projects at least ¼ in. (6mm) beyond the nut. Adjust the cable tension until the crosspiece on the top of the lever is square to the lever (when applied).
24. Adjust the main adjusting screw to get full application of the brakes between two and eight notches on the lever.
25. Reinstall the console assembly over the parking brake mechanism. Reinstall the wheel(s) and lower the vehicle.

700 Series

SHORT CABLE — RIGHT SIDE

1. Jack up the rear of the car and safely support it with jackstands.
2. Remove the right rear wheel. Remove the right brake caliper and hang it from the coil spring with a wire. Remove the brake disc. Unhook the rear return spring and remove the brake shoes.
3. Push out the pin holding the cable to the brake lever. Remove the rubber boot from the backing plate and remove the boot from the cable.

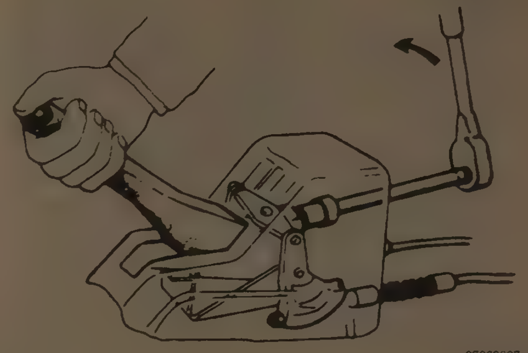

Fig. 67 Adjust the parking brake cable so that the brakes are fully applied between the second and eighth notches

4. Remove the spring clip, pin and cable from the back of the differential housing. Remove the cable guide on the differential by removing the top bolt from the housing cover. Remove the cable.
5. Install the boot on the new cable. Check the boots for wear or damage and replace if necessary. Install the cable and position it through the hole in the backing plate. Make sure the boot sits correctly on the backing plate.
6. Smear the contact surfaces of the brake levers with a thin layer of heat-resistance graphite grease. Connect the cable to the lever and install the pin.

➡The arrow stamped on the lever should face upwards and point outwards.

7. Push the cable through and place the lever in position behind the rear axle flange.
8. Install the cable guide on the axle. Connect the cable to the equalizer using the pin and spring clip.
9. Install the brake shoes and rear return spring. Install the brake disc and caliper. Use new bolts, and tighten to to 43 ft. lbs. (58 Nm). Make sure the disc rotates freely. Adjust the parking brake. Install the wheel and lower the car.

LONG CABLE — LEFT SIDE

1. Remove the center console.
2. Loosen the parking brake adjusting screw. Remove the cable lock ring and remove the cable. Pull out the cable from the spring sleeve.
3. Jack up the rear end of the car and safely support it on jackstands. Remove the left rear wheel.
4. Remove the left rear brake caliper and hang it from the coil spring with a piece of wire. Remove the brake disc and rear return spring. Remove the brake shoes.
5. Push out the pin holding the cable to the lever. Remove the rubber boot from the backing plate, and remove the boot from the cable.
6. Pull out the cable from the backing plate and the equalizer on top of the rear axle.
7. Remove the cable clamp on the sub-frame (above the driveshaft) and the cable.

8. Install the new cable through the grommet in the floor; check that the grommet sits correctly. Clamp the cable to the sub-frame.

9. Smear the contact surfaces of the brake levers with a thin layer of heat-resistance graphite grease. Connect the cable to the lever and install the pin.

➡The arrow stamped on the lever should face upwards and point outwards.

10. Push the cable through and place the lever in position behind the rear axle flange.

11. Install the cable guide on the axle. Connect the cable to the equalizer using the pin and spring clip.

12. Install the brake shoes and rear return spring. Install the brake disc and caliper. Use new bolts, and tighten to 43 ft. lbs. (58 Nm). Make sure the disc rotates freely. Adjust the parking brake. Install the wheel and lower the car.

Parking Brake Shoe

REPLACEMENT

➧ See Figures 68 and 69

1. Using the appropriate procedure described in the brake cable adjustment, gain access to the adjuster and loosen it so that the tension is removed from the cable.
2. Elevate and safely support the rear end.
3. On 200 series, remove the brake line-to-axle clamp.
4. Remove the caliper and hang it out of the way. Be careful not to crimp hoses or lines.
5. Remove the disc. The hub is between you and the brake shoes but you can work around it. Don't attempt to remove the hub.
6. Using brake spring pliers, remove one retaining spring from the shoe assembly. (700 Series have only one spring.) Remove the shoes from the car, taking note of the location and placement of the adjuster.
7. Assemble the shoes with one spring and install onto the car. Install the other retaining spring, except 700 Series.
8. Install the brake disc. Check that the disc turns freely without binding on the shoes.
9. Reinstall the brake caliper. Always use new retaining bolts and tighten them to 42 ft. lbs. (57 Nm).
10. On 200 Series, reinstall the brake line-to-axle clamp.
11. Adjust the brake shoes (except 700 Series) and then the brake cables as described in this section.
12. Reinstall the wheels and lower the car to the ground. Check the parking brake for proper holding and adjust the cables as necessary.

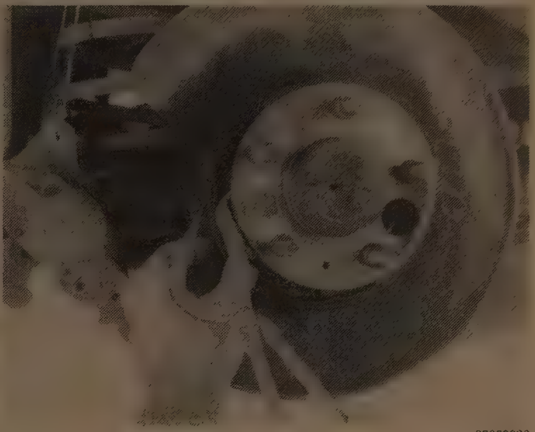

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Fig. 68 Use brake spring pliers to remove one retaining spring

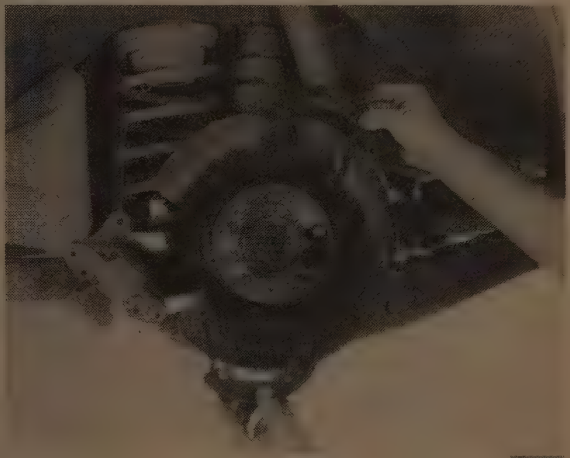

Fig. 69 Remove the brake shoes, adjuster and springs

Brake Specifications

All measurements given are (in.) unless noted

		Lug Nut Torque	Master Cylinder	Brake Disc		Brake Disc Diameter		Minimum Lining Thickness	
Year	Model	(ft. lbs.)	Bore	Minimum Thickness	Maximum Run-Out	Front Disc	Rear Disc	Front	Rear
1970–72	140 Series	70–100	0.882	0.457[1] 0.331[2]	0.004[1] 0.006[2]	10.7	11.63	0.125	0.125
	164	70–100	0.950	0.457[1] 0.331[2]	0.004[1] 0.006[2]	10.7	11.63	0.125	0.125
	1800 E ES	70–100	0.882	0.520[1] 0.330[2]	0.004[1] 0.006[2]	10.6	11.63	0.125	0.125
1973	140 Series	70–100	0.882[3]	0.457[1] 0.331[2]	0.004[1] 0.006[2]	10.7	11.63	0.125	0.125
	164	70–100	0.950[4]	0.900[1] 0.331[2]	0.004[1] 0.006[2]	10.7	11.63	0.125	0.125
	1800 ES	70–100	0.882	0.520[1] 0.331[2]	0.004[1] 0.006[2]	10.6	11.63	0.125	0.125
1974	140 Series	70–100	0.875	0.457[1] 0.331[2]	0.004[1] 0.006[2]	10.7	11.63	0.125	0.125
	164	70–100	0.875	0.900[1] 0.331[2]	0.004[1] 0.006[2]	10.7	11.6	0.125	0.125
1975	240 Series	70–100	0.877	0.557[1] 0.331[2]	0.004[1] 0.006[2]	10.35	11.06	0.125	0.125
	164	70–100	0.875	0.900[1] 0.331[2]	0.004[1] 0.006[2]	10.7	11.63	0.125	0.125
1976–83	240 Series, DL, GL, GT, Turbo	88	0.878	0.557[1] 0.331[2]	0.004[1] 0.006[2]	10.35	11.06	0.125	0.125
	260 Series, GLE, Coupe, Diesel	88	0.878	0.900[1] 0.331[2]	0.004[1] 0.006[2]	10.35	11.06	0.125	0.125
	760 GLE	63	0.878	0.551[1] 0.378[2]	0.003[1] 0.004[2]	11.02	11.06	0.118	0.078
84–89	240 Series	63	0.88	0.500[5] 0.803[6] 0.330[2]	0.004[1] 0.004[1] 0.004[2]	10.33	11.06	0.120	0.012
84–89 84–87	740 and 760	63	0.878[7] 0.938[8]	0.433[5] 0.790[6] 0.330[2]	0.003[1] 0.004[2]	11.03[5] 11.31[6]	11.06	0.118	0.078
88–89	760 & 780	63	0.878[7] 0.938[8]	0.433[5] 0.790[6] 0.315[2]	0.003[1] 0.080[2]	11.03[5] 11.31[6]	11.06	0.118	0.078

[1] Front

[2] Rear

[3] Master cylinder bore is 0.875 starting from chassis nos: 377809 on 142, 403575 on 144, and 194933 on 145

[4] Master cylinder bore is 0.875 starting from chassis no. 79021

[5] Front—solid disc

[6] Front—vented disc

[7] Early type

[8] Late type

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Troubleshooting the Brake System

Problem	Cause	Solution
Low brake pedal (excessive pedal travel required for braking action)	• Excessive clearance between rear linings and drums caused by inoperative automatic adjusters	• Make 10 to 15 alternate forward and reverse brake stops to adjust brakes. If brake pedal does not come up, repair or replace adjuster parts as necessary.
	• Worn rear brakelining	• Inspect and replace lining if worn beyond minimum thickness specification
	• Bent, distorted brakeshoes, front or rear	• Replace brakeshoes in axle sets
	• Air in hydraulic system	• Remove air from system. Refer to Brake Bleeding.
Low brake pedal (pedal may go to floor with steady pressure applied.)	• Fluid leak in hydraulic system	• Fill master cylinder to fill line; have helper apply brakes and check calipers, wheel cylinders, differential valve tubes, hoses and fittings for leaks. Repair or replace as necessary.
	• Air in hydraulic system	• Remove air from system. Refer to Brake Bleeding.
	• Incorrect or non-recommended brake fluid (fluid evaporates at below normal temp)	• Flush hydraulic system with clean brake fluid. Refill with correct-type fluid.
	• Master cylinder piston seals worn, or master cylinder bore is scored, worn or corroded	• Repair or replace master cylinder
Low brake pedal (pedal goes to floor on first application—o.k. on subsequent applications.)	• Disc brake pads sticking on abutment surfaces of anchor plate. Caused by a build-up of dirt, rust, or corrosion on abutment surfaces	• Clean abutment surfaces
Fading brake pedal (pedal height decreases with steady pressure applied)	• Fluid leak in hydraulic system	• Fill master cylinder reservoirs to fill mark, have helper apply brakes, check calipers, wheel cylinders, differential valve, tubes, hoses, and fittings for fluid leaks. Repair or replace parts as necessary.
	• Master cylinder piston seals worn, or master cylinder bore is scored, worn or corroded	• Repair or replace master cylinder
Decreasing brake pedal travel (pedal travel required for braking action decreases and may be accompanied by a hard pedal.)	• Caliper or wheel cylinder pistons sticking or seized	• Repair or replace the calipers, or wheel cylinders
	• Master cylinder compensator ports blocked (preventing fluid return to reservoirs) or pistons sticking or seized in master cylinder bore	• Repair or replace the master cylinder
	• Power brake unit binding internally	• Test unit according to the following procedure: (a) Shift transmission into neutral and start engine (b) Increase engine speed to 1500 rpm, close throttle and fully depress brake pedal (c) Slow release brake pedal and stop engine (d) Have helper remove vacuum check valve and hose from power unit. Observe for backward movement of brake pedal. (e) If the pedal moves backward, the power unit has an internal bind—replace power unit

Troubleshooting the Brake System (cont.)

Problem	Cause	Solution
Spongy brake pedal (pedal has abnormally soft, springy, spongy feel when depressed.)	• Air in hydraulic system	• Remove air from system. Refer to **Brake Bleeding.**
	• Brakeshoes bent or distorted	• Replace brakeshoes
	• Brakelining not yet seated with drums and rotors	• Burnish brakes
	• Rear drum brakes not properly adjusted	• Adjust brakes
Hard brake pedal (excessive pedal pressure required to stop vehicle. May be accompanied by brake fade.)	• Loose or leaking power brake unit vacuum hose	• Tighten connections or replace leaking hose
	• Incorrect or poor quality brakelining	• Replace with lining in axle sets
	• Bent, broken, distorted brakeshoes	• Replace brakeshoes
	• Calipers binding or dragging on mounting pins. Rear brakeshoes dragging on support plate	• Replace mounting pins and bushings. Clean rust or burrs from rear brake support plate ledges and lubricate ledges with molydisulfide grease. **NOTE:** If ledges are deeply grooved or scored, do not attempt to sand or grind them smooth—replace support plate
	• Caliper, wheel cylinder, or master cylinder pistons sticking or seized	• Repair or replace parts as necessary
	• Power brake unit vacuum check valve malfunction	• Test valve according to the following procedure: (a) Start engine, increase engine speed to 1500 rpm, close throttle and immediately stop engine (b) Wait at least 90 seconds then depress brake pedal (c) If brakes are not vacuum assisted for 2 or more applications, check valve is faulty
	• Power brake unit has internal bind	• Test unit according to the following procedure: (a) With engine stopped, apply brakes several times to exhaust all vacuum in system (b) Shift transmission into neutral, depress brake pedal and start engine (c) If pedal height decreases with foot pressure and less pressure is required to hold pedal in applied position, power unit vacuum system is operating normally. Test power unit. If power unit exhibits a bind condition, replace the power unit
	• Master cylinder compensator ports (at bottom of reservoirs) blocked by dirt, scale, rust, or have small burrs (blocked ports prevent fluid return to reservoirs)	• Repair or replace master cylinder **CAUTION:** Do not attempt to clean blocked ports with wire, pencils, or similar implements. Use compressed air only
	• Brake hoses, tubes, fittings clogged or restricted	• Use compressed air to check or unclog parts. Replace any damaged parts
	• Brake fluid contaminated with improper fluids (motor oil, transmission fluid, causing rubber components to swell and stick in bores	• Replace all rubber components, combination valve and hoses. Flush entire brake system with DOT 3 brake fluid or equivalent
	• Low engine vacuum	• Adjust or repair engine

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Troubleshooting the Brake System (cont.)

Problem	Cause	Solution
Grabbing brakes (severe reaction to brake pedal pressure.)	• Brakelining(s) contaminated by grease or brake fluid	• Determine and correct cause of contamination and replace brakeshoes in axle sets
	• Parking brake cables incorrectly adjusted or seized	• Adjust cables. Replace seized cables.
	• Incorrect brakelining or lining loose on brakeshoes	• Replace brakeshoes in axle sets
	• Caliper anchor plate bolts loose	• Tighten bolts
	• Rear brakeshoes binding on support plate ledges	• Clean and lubricate ledges. Replace support plate(s) if ledges are deeply grooved. Do not attempt to smooth ledges by grinding.
	• Incorrect or missing power brake reaction disc	• Install correct disc
	• Rear brake support plates loose	• Tighten mounting bolts
Dragging brakes (slow or incomplete release of brakes)	• Brake pedal binding at pivot	• Loosen and lubricate
	• Power brake unit has internal bind	• Inspect for internal bind. Replace unit if internal bind exists.
	• Parking brake cables incorrrectly adjusted or seized	• Adjust cables. Replace seized cables.
	• Rear brakeshoe return springs weak or broken	• Replace return springs. Replace brakeshoe if necessary in axle sets.
	• Automatic adjusters malfunctioning	• Repair or replace adjuster parts as required
	• Caliper, wheel cylinder or master cylinder pistons sticking or seized	• Repair or replace parts as necessary
	• Master cylinder compensating ports blocked (fluid does not return to reservoirs).	• Use compressed air to clear ports. Do not use wire, pencils, or similar objects to open blocked ports.
Vehicle moves to one side when brakes are applied	• Incorrect front tire pressure	• Inflate to recommended cold (reduced load) inflation pressure
	• Worn or damaged wheel bearings	• Replace worn or damaged bearings
	• Brakelining on one side contaminated	• Determine and correct cause of contamination and replace brakelining in axle sets
	• Brakeshoes on one side bent, distorted, or lining loose on shoe	• Replace brakeshoes in axle sets
	• Support plate bent or loose on one side	• Tighten or replace support plate
	• Brakelining not yet seated with drums or rotors	• Burnish brakelining
	• Caliper anchor plate loose on one side	• Tighten anchor plate bolts
	• Caliper piston sticking or seized	• Repair or replace caliper
	• Brakelinings water soaked	• Drive vehicle with brakes lightly applied to dry linings
	• Loose suspension component attaching or mounting bolts	• Tighten suspension bolts. Replace worn suspension components.
	• Brake combination valve failure	• Replace combination valve
Chatter or shudder when brakes are applied (pedal pulsation and roughness may also occur.)	• Brakeshoes distorted, bent, contaminated, or worn	• Replace brakeshoes in axle sets
	• Caliper anchor plate or support plate loose	• Tighten mounting bolts
	• Excessive thickness variation of rotor(s)	• Refinish or replace rotors in axle sets
Noisy brakes (squealing, clicking, scraping sound when brakes are applied.)	• Bent, broken, distorted brakeshoes	• Replace brakeshoes in axle sets
	• Excessive rust on outer edge of rotor braking surface	• Remove rust

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Troubleshooting the Brake System (cont.)

Problem	Cause	Solution
Noisy brakes (squealing, clicking, scraping sound when brakes are applied.) (cont.)	• Brakelining worn out—shoes contacting drum of rotor	• Replace brakeshoes and lining in axle sets. Refinish or replace drums or rotors.
	• Broken or loose holdown or return springs	• Replace parts as necessary
	• Rough or dry drum brake support plate ledges	• Lubricate support plate ledges
	• Cracked, grooved, or scored rotor(s) or drum(s)	• Replace rotor(s) or drum(s). Replace brakeshoes and lining in axle sets if necessary.
	• Incorrect brakelining and/or shoes (front or rear).	• Install specified shoe and lining assemblies
Pulsating brake pedal	• Out of round drums or excessive lateral runout in disc brake rotor(s)	• Refinish or replace drums, re-index rotors or replace

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EXTERIOR

Doors

REMOVAL & INSTALLATION

➧ See Figure 1

✻✻CAUTION

The door(s) are heavy! Provide proper support for the door when removing. Do not allow the door to sag while partially attached and do not subject the door to impact or twisting movements.

140 and 160 Series and 1800 Series

1. Remove the door panel (inner trim pad) following the instructions given in Door Panel Removal and Installation later in this section.
2. Disconnect and, if necessary, remove the door stop mechanism. On 1800 series, simply drive or drill the pivot pin free at the pillar; the arm will then be free of the body. For 140 and 160 series, unbolt the bracket from the pillar.
3. Open the door until the hinge bolts can be easily reached. Remember that the door stop is disconnected; don't open the door too far or you may damage paint or metalwork.
4. Remove the retaining bolts holding the hinge to the body. Have an assistant hold the door and support it during removal. Once the door is free of the body, the hinges may be removed from the door if desired.
5. When reinstalling, place the door in position and seat the hinge bolts finger tight. When the bolts are tight enough to hold the door in place, but loose enough to allow adjustment, close the door and check the alignment of the door seams. All the seams (gaps) should be even in width; the leading edge gap should be the same width as the trailing edge gap, and the weather strip should be evenly compressed around the door. The door is three-way adjustable on its hinges. The door may be moved fore-and-aft or up and down on its hinge mounts. If adjustment towards or away from the body is necessary, shims may be placed (or removed) between the hinge and the body.
6. After the door is positioned correctly, tighten the mounting bolts and recheck the door fit.
7. Install the door stop mechanism and check its function.
8. Install the door trim pad.

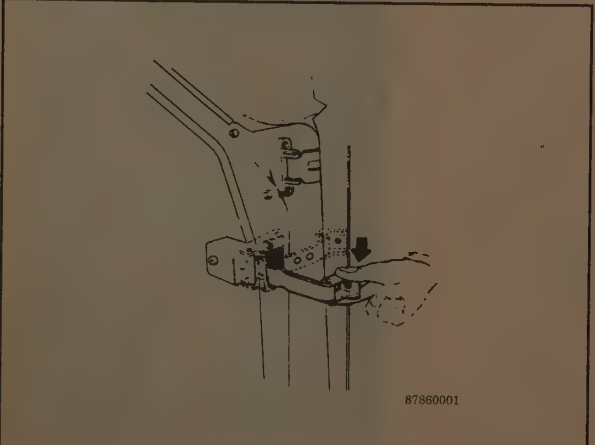

Fig. 1 Remove the door stop bracket as shown — 100 and early 200 series

200 and 700 Series

➧ See Figure 2

1. Disconnect any wiring harnesses running into the door. This may be done either inside the door (remove the door liner) or under the dash inside the pillar. Make sure the wiring harness will not catch or bind as the door is removed from the car.
2. On the earlier 200 series, remove the bolt holding the door stop bracket to the body. Later cars have the stop included in the lower hinge.
3. Have an assistant support the door; loosen and remove the four bolts holding the hinge to the door.
4. When reinstalling, have your helper position the door and install the hinge bolts. If the hinges were not removed from the body, the door should be in alignment. If not, the hinge-to-body bolts must be loosened just enough to allow the door to be moved into position. Tighten all the hinge bolts and check the final fit.
5. If the door stop bracket was removed, reinstall it.
6. Connect the wiring harness and check the function of electrical components in the door.

DOOR ALIGNMENT and ADJUSTMENT

➧ See Figures 3, 4 and 5

As explained above, the primary door adjustments are carried out at the hinge bolts at the forward end of each door. Further adjustment for closed position and for smoothness of

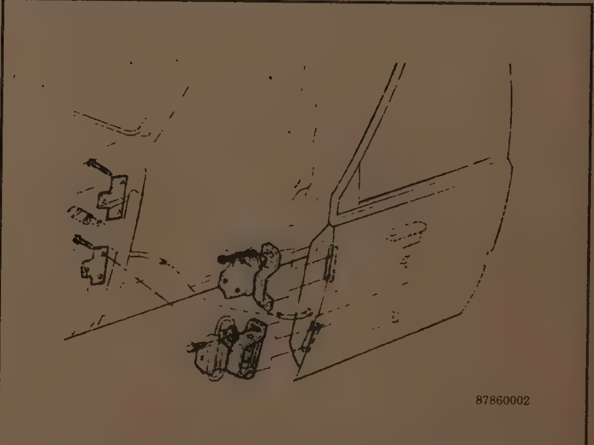

Fig. 2 Exploded view of the door hinge assembly — 700 series

latching may be made at the latch plate or striker. This piece is located at the rear edge of the door and is attached to the bodywork of the car; it is the piece the door engages when closed.

Although the striker or latch plate is different on various models, the procedure for adjusting is the same:

1. Loosen the large Phillips screw(s) holding the striker. Know in advance that these bolts will be very tight — an impact screwdriver is a very handy tool for this job — make sure you use the correct size bit.
2. With the bolts just loose enough to allow the striker to move if necessary, hold the outer door handle in the released position and close the door. The striker will move into the correct location to match the door latch. Open the door and tighten the mounting bolts. The striker may be adjusted towards or away from the center of the car, thereby pulling the door tighter to the body if needed. The 140 and 160 series require a 1.5° inward angle on the front strikers and a 2.5° inward angle on the rear stickers.

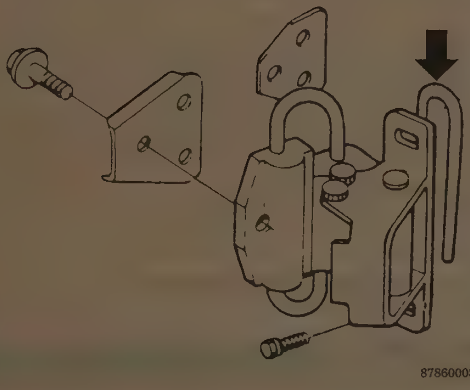

Fig. 3 Exploded view of the 700/late 200 series lower hinge assembly — the arrows indicate where to place shims to laterally adjust the door

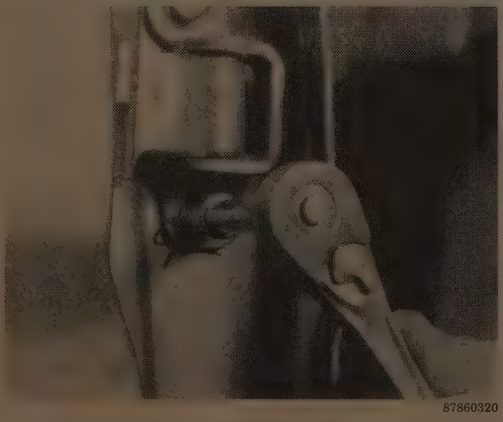

Fig. 4 Adjust the door by loosening the hinge bolts, then positioning it as necessary — note alignment mark drawn as a reference to the original position

Fig. 5 Loosen the striker plate just enough to manipulate it as needed — again, note the reference mark

➡Do not attempt to correct height variations (sag) by adjusting the striker.

3. After the striker bolts have been tightened, open and close the door several times. Observe the motion of the door as it engages the striker; it should continue its straight-in motion and not deflect up or down as it hits the striker.

Check the feel of the latch during opening and closing. It must be smooth and linear, without any trace of grinding or binding during engagement and release.

It may be necessary to repeat the striker adjustment procedure several times (and possibly adjust the hinges) before the correct door-to-body match is produced.

Hood

REMOVAL & INSTALLATION

All Models Except 1800 Series

➧ See Figure 6

1. Raise the hood. Disconnect any electrical or fluid lines between the hood and the body.
2. Have an assistant support the hood so it doesn't damage the body during removal. Remove the hinge-to-hood bolts on each side and lift the hood clear of the car.

➡Hoods are getting lighter; take great care not to bend or dimple the hood. Store it on pads and cover it to protect it while off the car.

3. When reinstalling, position the hood and install the bolts just tight enough to hold it in position. Lower the hood and check the alignment — the gap should be even all around. With the hinge bolts finger tight, the hood may be moved on the hinges to align it. Vertical adjustment is adjusted by installing shims between the hood and the hinges.

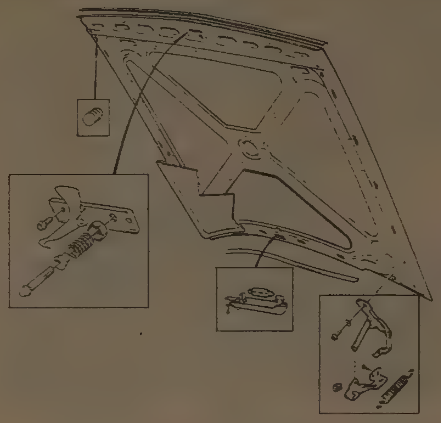

Fig. 6 Hood components — 200 series shown. 100 and 700 series models are similar

4. Tighten the bolts and recheck the fit and latching — adjust as necessary.
5. Reconnect any electrical or fluid lines between the hood and body.

1800 Series

1. Raise the hood. Remove the outer part of the air cleaner. This will allow access to the right side hinge bolt. Unbolt the hood support and lower but do not latch the hood.
2. Using a pair of pliers, remove the lower clamps on the radiator grille. Lift the grille clear of the car by pulling it out at the lower edge first.
3. Loosen and remove the hood hinge bolts. Lift the hood clear of the car.
4. When reinstalling, line the hood up by viewing the seam between the hood and the bodywork — the gap should be even all around. With the hinge bolts finger tight, the hood may be moved on the hinges to align it. Vertical adjustment is adjusted by installing shims between the hood and the hinges.
5. Tighten the bolts and check the fit and latching — adjust as needed.
6. Install the grille and its clamps.
7. Raise the hood and install the hood prop. Install the outer part of the air cleaner.

ADJUSTMENT

For all Volvo products, the hood is adjustable at the hinges as discussed above. Additionally, the hood latch is adjustable by loosening the two bolts holding the latch to the hood and moving it for-and-aft as necessary to get the correct match. Any side to side adjustment must be done at the hinges.

➡If one of these cushions is missing, the hood can make a rattle or banging noise which is often mistaken for suspension noise.

The closed height of the hood is adjustable by turning the hood stops — rubber bumpers mounted either on the bodywork (early cars) or on the hood itself. These rubber stops allow the hood to be brought into alignment with the height of the fenders on either side.

Trunk Lid

REMOVAL & INSTALLATION

2-Door and 4-Door models

➧ See Figure 7

1. Open the trunk lid. Have an assistant support the lid; remove the retaining clip for the gas shock (which holds the lid open) and disconnect it from the lid. On 1800 series, the lid is held open by two torsion rods. They need not be disconnected to remove the trunk lid.
2. Disengage any wiring to the trunk lid at the nearest connector. Make sure the wiring will not bind when the lid is removed.
3. Remove the bolts which hold the hinges to the trunk lid and lift the lid clear of the car. Use caution not to warp or dimple the lid. The hinges may then be unbolted from the body if desired, but this may require removing some cover panels for access to the bolts. On the 1800 series, the hinges and torsion rods are removed as a unit.
4. When reinstalling, the lid is placed in position and the bolts tightened only snug. Check the lid-to-body match and adjust the trunk lid as necessary.
5. Reconnect the gas shock to the trunk lid and reconnect the wiring, if any.

Wagon (5-door) Models Except 1800 ES

➧ See Figure 8

✱✱CAUTION

Because of the size and weight of the cargo door, this procedure REQUIRES two people during removal and installation.

1. Disconnect the negative battery cable.

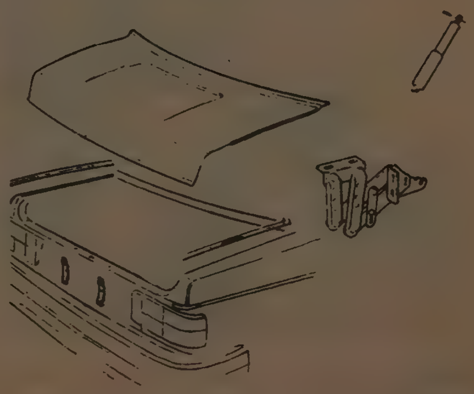

Fig. 7 Exploded view of the trunk lid and hinge

2. Remove the inner cover panel on the cargo door. Disengage any electrical connectors within the door. On the 145 model, remove the left license plate lamp and its electrical cable. Tag or identify the connectors for ease of reassembly.
3. Pull the harness through the hole in the top of the door.
4. Have your helper support the door; disconnect the gas shock(s) from the door. On the 145, disconnect the mechanical support on the opposite side as well.
5. With the door well supported, remove the door-to-hinge bolts on each side at the top. On the 740, one of the bolts is beneath a rubber plug which must be removed. Carry the door away from the car and store on pads.
6. When reinstalling, install the bolts snug but not tight; check the alignment of the door in relation to the body and adjust the door as necessary. When the alignment is correct, tighten the hinge bolts. Left-right alignment is critical on the cargo door. Take your time and work for an even fit.
7. Connect the gas shock(s) to the door.
8. Feed the wire harness through the hole at the top of the door and into position. Connect the wires to the proper points. On the 145 series, reinstall the left license plate light.

1800 ES

The hatch of the 1800 ES is all glass, with the hinges and latch mounted on rubber bushings. After disconnecting the wire for the defroster and removing the gas shock, the glass is removed by simply unbolting the hinge nuts and lifting the glass clear.

Extreme care must be taken not to hit or scratch the glass during removal. When reinstalling, correct placement of the rubber seals must be observed to avoid shattering the glass. At no time should any steel component come into direct contact with the glass. The mounting bolts should be tightened just enough to hold with no attempt made to overtighten.

ALIGNMENT

All Models

See Figures 9, 10 and 11

Both trunk lids and wagon doors are adjustable on their hinges due to slotted holes. The trunk lids are also adjustable by loosening the hinge-to-body bolts and repositioning the hinge vertically. The 1800 ES has only minimal adjustment in the glass mounts.

Wagon cargo doors have additional adjustors on the sides of the door. Loosen their screws a few turns and close the door. The adjustor should seek the correct position for smooth operation. Because of the curve of the body and roofline, the wagon door needs to be checked carefully for alignment to the body. Seams should be straight and even and panels should be flush with no obvious high or low points.

Final adjustments are made at the latch (on the lid) and the striker (on the body). Each can be loosened and moved on its

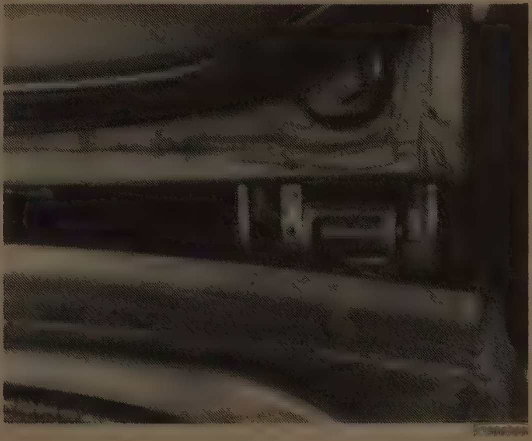

Fig. 9 The station wagon rear cargo door is adjustable at the hinges

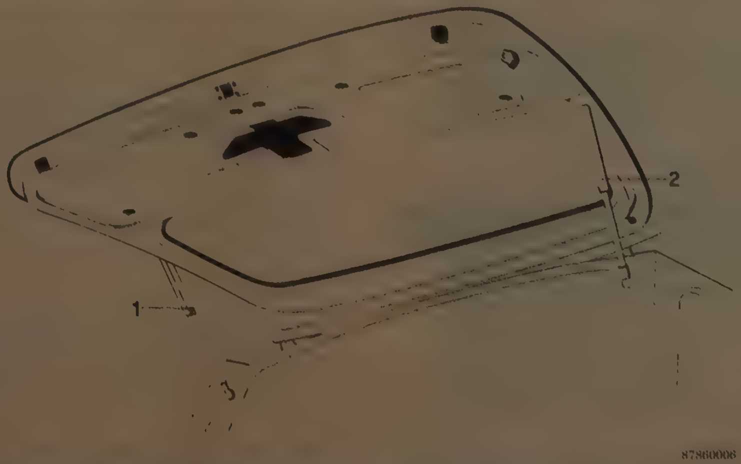

Fig. 8 To remove the tailgate, disconnect the mechanical arm (1) and the gas shock (2)

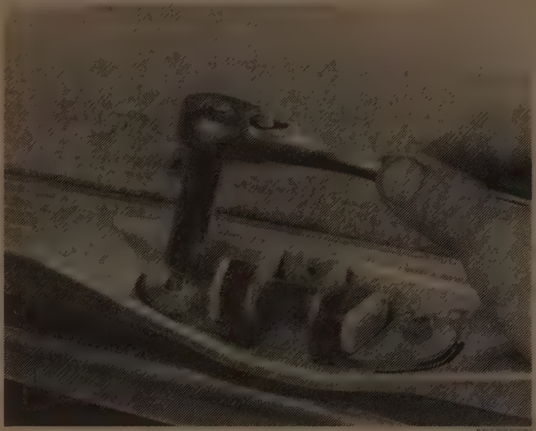

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Fig. 10 Adjustment may also be fine-tuned by loosening and sliding striker plate

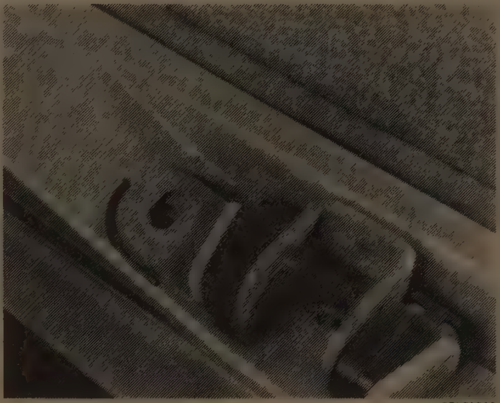

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Fig. 11 Note the elongated holes in contrast to the mounting bolt holes — the black pen tracing allows you to put the striker back as found, if desired

mounts to control tightness and ease of operation. It is recommended to start by loosening the striker only; close the lid and let the striker seek its position. (This maddening little job can drive you off the deep end after a few cycles of loosen it, tighten it, open it, close it.) Continue adjusting until the latch has no bind in its operation, the key turns freely and the weatherstrip is evenly compressed around the door.

Bumpers

REMOVAL & INSTALLATION

140, 160 and 1800 Series

Both the front and rear bumpers of these cars are composed of various sections bolted together. The bumpers are mounted to the car on four support brackets (1800 ES: six brackets). The retaining nuts and bolts are loosened and removed; the bumper may then be removed from the car as a unit and disassembled into component parts on the workbench.

The retaining bolts are reached from under the car (behind the bumper). It may be easier to elevate and support the car before beginning. The bumper bolts are sure to be rusted solid — have a healthy supply of penetrating oil at hand. The steel bumpers are reasonably heavy — don't drop one on yourself while lying under the car.

When reinstalling the bumper, make sure that it aligns properly with the bodywork. Since it runs the full width of the car, the slightest mounting error can make it look crooked.

200 and 700 Series

➧ **See Figures 12 and 13**

As government regulations tightened in the early and mid 1970s, bumpers were redesigned to include impact absorption. This is generally accomplished through the use of gas-filled shock absorbers which allow the bumper to move inward under light impact. The design of the bumpers changed to accommodate the shocks; bumpers are now steel or aluminum beams bolted to the shocks with a plastic cover on the outside. For both front and rear bumpers on cars built after model year 1974:

1. Loosen the sides of the bumper cover by either removing the nuts or releasing the plastic clip. The nuts will be found inside the trunk or on the inside of the front fender. On certain models, the front air dam (spoiler) must be removed before removing the front bumper.
2. Under the car, identify the bolts which hold the bumper assembly to the shock absorbers. Loosen them a few turns and wiggle the bumper outwards, checking that it will come free without damage.
3. Remove the bolts on one side. Either allow the bumper to rest on the ground or support it on a box until the other side is free.
4. Remove the bolts on the other side and remove the bumper. Take note of any spacers which may have been placed for alignment.

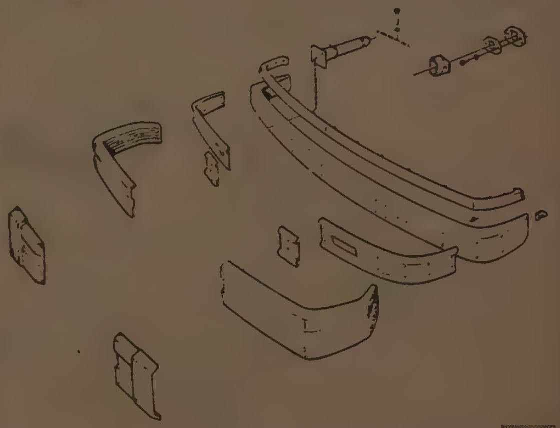

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Fig. 12 Exploded view of the front bumper assembly — 200 series

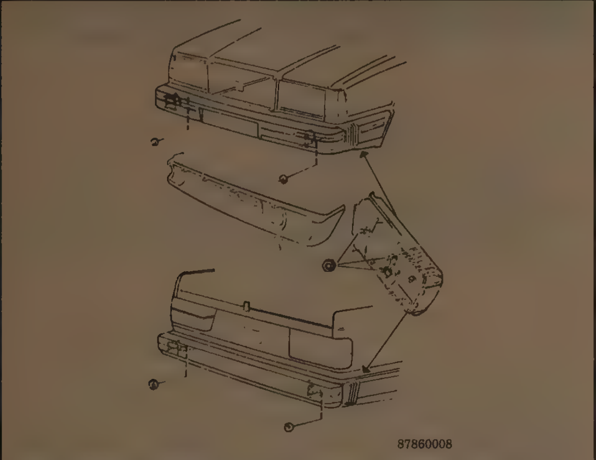

Fig. 13 Exploded views of the front and rear bumper mounting — 700 series

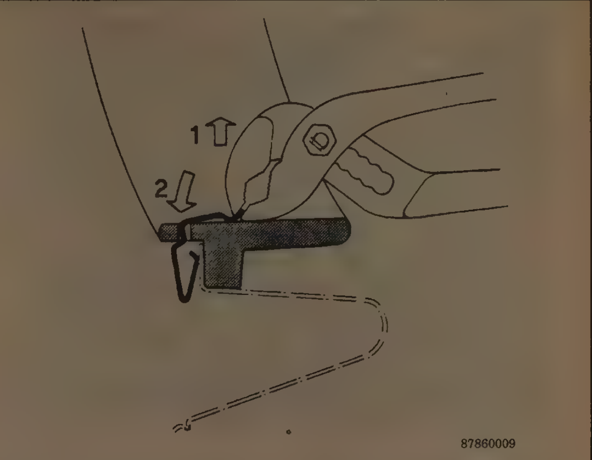

Fig. 14 Remove the lower grille clips as shown — 1800 series

5. With the bumper removed, the shocks may be unbolted and replaced if needed.

CAUTION

Gas filled shocks must not be discarded in the trash. Take them to your dealer or a reputable body shop so that they may be properly drilled and vented before disposal. Do not attempt to drill the shocks yourself — injury can result.

6. When reinstalling, make sure the bumper lines up straight to the body work. Install the retaining bolts and tighten them.
7. Secure the side mounts of the bumper cover with the proper nuts or clips. Install the air dam if it was removed.

Grille

REMOVAL & INSTALLATION

1800 Series

See Figure 14

1. Using a pair of pliers, loosen the lower clamps.
2. Lift out the grille by swinging the lower part out first.
3. When reinstalling, place the upper edge in position first and make sure the clips seat properly.
4. Install the lower clamps. Place the clamp above the hole and press it into place.

140 and 160 Series

The aluminum grille is removed simply by removing the retaining screws. Use care not to crush the metal or mar the polished finish on the grille.

200 and 700 Series

See Figures 15 and 16

The plastic grilles on these cars are retained by a variety of plastic clips and screws. With the hood raised, remove all the retaining hardware and lift the grille clear of the car. On later cars, be careful of any wires and/or tubing running between the grille and the radiator. Do not force the grille into position or it will crack; work carefully and make sure everything lines up before tightening the mounting hardware.

Fog Lights

REMOVAL AND INSTALLATION

160 Series

1. Inside the engine compartment, remove the screw and the plastic cover over the back of the lighting units.
2. Disconnect the wire from the fog light.
3. Squeeze the holder together and pull it straight back, releasing the bulb.

Fig. 15 Remove all screws and plastic clips that retain the grille — be careful not to break the clips. Any that are must be purchased from a Volvo dealer

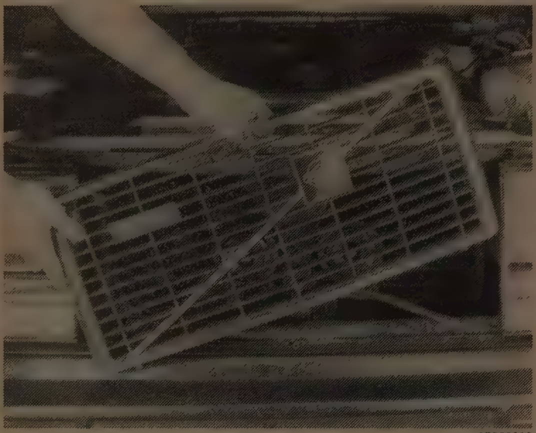
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Fig. 16 Remove the disconnected grille, then stand it on its edge in a safe place

4. Remove the old bulb and install the new one. Make sure the bulb is properly seated; the guides on the bulb will only allow it to lock in place in one position.

WARNING

Do not touch the glass part of the bulb with your fingers. If this should happen accidentally, clean the lamp with alcohol and dry it with a lint-free cloth. Grease on the glass will cause hot spots and shorten the life of the bulb.

5. Refit the holder and connect the wire. Install the plastic cover and its screw.

200 Series

While the 200 series does not have integrated front fog lights (they can be added as separate units), in the mid-80s the cars began arriving with rear fog lights. Although these lamps appear to be the same as the red tail lights, they use a higher intensity (wattage) lamp.

The lamp is changed in identical fashion to a tail light bulb but care must be used in purchasing the replacement. The bulb will have identifying codes on its base and these codes should be matched exactly when replacing the lamp.

700 Series

See Figure 17

Cars in the 700 series may have front fog lamps either integrated into the headlight assembly or installed as separate units below the bumper.

1. Turn the integrated type bulb a quarter turn counterclockwise to release the socket from the lamp assembly. You may have to remove the washer reservoir to gain access.
2. With the socket removed, release the side catches and remove the lamp.

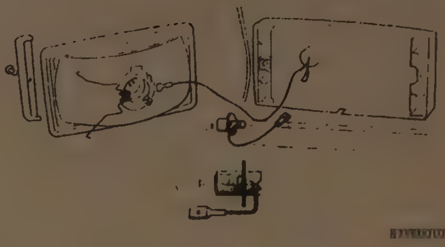

Fig. 17 The replacement bulb for below-the-bumper foglights fits behind the lamp assembly as shown

To install:

3. Hold the lamp only by the base and do not touch the glass with your fingers. Make sure it is correctly positioned within the lens housing.

To change the bulb in a separately mounted foglight:

4. Remove the screw in the vertical plastic retainer on each side of the foglight lens and remove the retainers.
5. Carefully lift the glass lens assembly out of the plastic mount. There are wires attached to the back of it.
6. Disengage the wires to the lamp and the ground connection. Note that the connectors are different; they will only reassemble in the correct manner.
7. On the back of the lens, push down on the ends of the spring clip and spread the clip out from under its holder. Swing the clip out of the way.
8. Pull the bulb out of the reflector. Install the new bulb in the reflector and make sure that the square notch in the bulb flange fits over the guide on the reflector.

WARNING

Do not touch the glass part of the bulb with your fingers. If this should happen accidentally, clean the lamp with alcohol and dry it with a lint-free cloth. Grease on the glass will cause hot spots and shorten the life of the bulb.

9. Swing the spring clip over the bulb and secure it in its clamps.
10. Reconnect the wiring to the ground and the bulb.
11. Place the reflector assembly back in the plastic housing and install the vertical retainers. Install the screws but do not overtighten.

The rear fog lights on all 700 series are integrated into the tail lamp assemblies. The bulbs are changed in identical fashion to the tail light bulbs, but care should be used in purchasing replacements. Note the code on the base of the bulb and obtain a replacement lamp of the same wattage.

Outside Mirrors

REMOVAL & INSTALLATION

See Figure 18

➡The manual mirrors on all Volvos do not offer replaceable glass. If the mirror is cracked or damaged, the complete mirror head must be replaced.

Manual Mirrors

1970-79 MODELS

The outside chromed mirrors on all Volvos may either be removed with its stalk by unbolting it from the door or may be removed from the stalk by unscrewing the pivot bolt behind the glass holder. Use the correct size screwdriver and don't strip the heads of the screws during removal.

1980-89 MODELS

1. Depending on the type of mirror, remove either the small screw in the back of the adjusting tab (inside the door) or remove the rubber boot over the adjusting lever.
2. Remove the adjuster mechanism and its covers. On the cable adjuster type, remove the bolt which holds the adjuster head to the door frame.
3. Remove the mounting bolts holding the mirror to the door frame. Support the mirror while doing this or it will fall when released. The adjusting cable must be fed through the door frame when removing.
4. When reinstalling, support the mirror during installation of the retaining screws. Make sure that any insulation or padding is put back in its correct location to reduce wind noise. If replacing a cable type mirror, thread the cable into position before securing the mounting bolts.
5. Install the adjuster tab or secure the cable retainer.
6. Attach any trim pieces and install either the locking screw or the rubber boot.

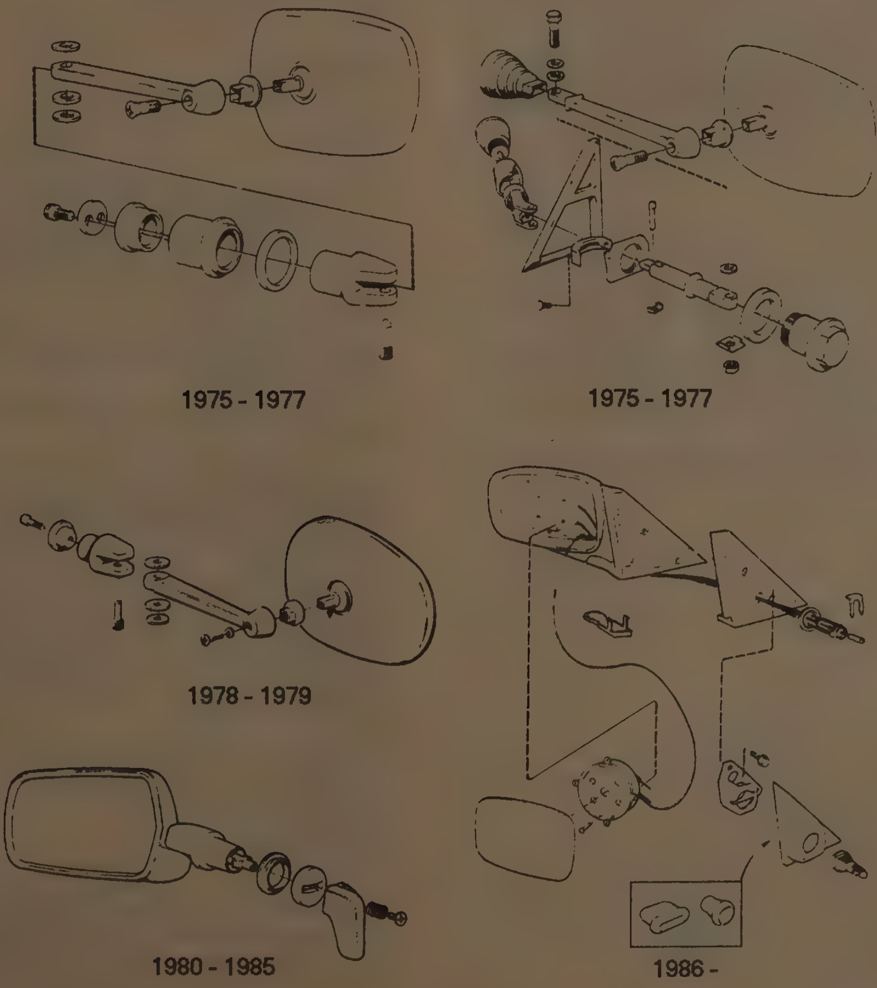

Fig. 18 Exploded view of common manual mirrors used on U.S. and Canadian Volvos

GLASS REPLACEMENT

Manual Mirrors

The outside chromed mirrors on all Volvos may either be removed with its stalk by unbolting it from the door or may be removed from the stalk by unscrewing the pivot bolt behind the glass holder. Use the correct size screwdriver and don't strip the screw heads during removal.

Electric Mirrors

1975-85 MODELS

➧ See Figure 19

➡This repair is best done inside under warm and dry conditions. The performance of the adhesive may be affected in other locations.

1. Pry the glass off the backing plate with a small prytool.
2. Clean the holder with alcohol; make sure all the old adhesive is removed.
3. Install the new piece of tape onto the mirror holder (backing plate). Make sure the tape is centered. If any air bubbles are trapped under the tape, puncture them with a pin.
4. Remove the backing paper(s) from the new glass. Align the mirror and press it into place against the tape. Pay attention . . . you only get one chance to mount the mirror straight.

1986-89 MODELS

➧ See Figure 20

1. With the mirror attached to the car, push in on the bottom of the glass until the cogs (teeth) can be seen through the hole in the bottom of the housing.
2. Use a small thin prytool to reach through the hole and slide the cogs to the right. Lift the mirror glass out.
3. Install the new glass, making sure the guides on the back of the mirror are in place.
4. Use the screwdriver to slide the cogs to the left and lock the glass in place.

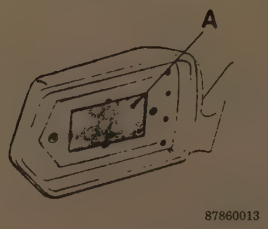

Fig. 19 Make sure the tape ("A") is centered before installing the mirror glass — puncture and flatten any trapped air bubbles with a pin — 1975-85 models

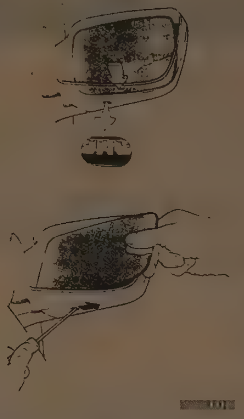

Fig. 20 When installing a new mirror glass, make sure the guides on the back of the mirror are in place — 1986 and later

MOTOR REPLACEMENT

Electric Mirrors

1975-85 MODELS

➧ See Figure 21

1. Remove the mirror from the door.
    a. For cars prior to 1980, remove the inner trim panel on the door. Disconnect the wiring harness running to the mirror. 1980 and later cars have the connector under the dash next to the fuse box.
    b. Remove the bolts holding the mirror assembly to the door and support the mirror while threading the wiring through the openings.
2. Remove the glass and pry off the plastic plug under the swivel point of the mirror "neck".
3. Tag or diagram the wiring on the back of the motor. Unplug the connectors.
4. Remove the plastic washer and pull out the wires. Remove the rubber cap on the motor and remove the mounting screws for the motor.
5. Install the rubber cap on the new motor. Place the new motor in position and insert the wiring through the flange. Tighten the motor screws.
6. Install the wiring and replace the plastic covering.
7. Replace the plug in the swivel point. Use a light adhesive to hold it in place.
8. Mount the mirror to the door, connect the wiring harness and reinstall the door pad.

1986-89 MODELS

➧ See Figure 22

1. Remove the glass as discussed previously.
2. Remove the motor-to-mirror frame screws.
3. Label or diagram the wiring on the back of the motor and disconnect the wiring. The round dust cover on the back of the motor must be transferred to the new motor.
4. Connect the wires to the new motor. Mount the motor and tighten the retaining screws.
5. Install the mirror glass.

INTERIOR

Door Panels (Trim Pads or Liners)

REMOVAL & INSTALLATION

1800, 140 and 160 Series

➧ See Figure 23

1. On 140 and 160 models, remove the armrest. It is retained by one or more screws, some hidden under plastic cover. Pop off the covers, remove the screws and, on the 160 series, turn the plastic ring at the front several turns to the left. Push the armrest forwards so that the hook at the front edge disengages. Remove the armrest.

2. Remove the window winder. Position the winder so that the arm points down. Push in on the hub of the winder, then push down on it. This should loosen the spring clip holding the winder onto the axle. An alternate method is to straighten a paper clip and bend a small "J" onto the bottom. Use it to reach between the winder and the door panel, snag the clip and pull it out. When doing this, keep your other hand over the top of the winder. Otherwise, when the clip comes free it will fly to an undisclosed location, never to be seen again.

3. The door panel is removed by gently prying the edge away from the door. Use a broad flat tool inserted between the panel and the metal of the door. The idea is to separate the clips without damage so they may be reused.

4. Proceed around the door until all the clips are released. Remove the door panel by lifting up to free the lip at the window edge.

➡Inside the door is either a paper or plastic moisture barrier. It may be removed for access to the door parts but it must not be ripped or torn. Should it become damaged, either replace it (plastic replacements are available for paper liners) or repair it with waterproof tape. It must be reinstalled intact after any door repairs

5. Before reinstalling the door panel, check every clip to insure that it is properly located and not damaged. Replace any that are unusable.

6. Position the door panel onto the top of the door and seat the lip at the window rail. It may require gentle tapping to seat properly.

7. Making sure each clip aligns with its hole, proceed around the door and tap each clip into place.

8. Fit the spring clip onto the window winder so that the open end points along the long part of the winder. Place the winder onto the axle — it was pointing down when you removed it — and give it a sharp tap. The winder will move into place and the clip will lock onto the slot in the axle.

9. On 140 and 160 series, reinstall the armrest. Don't forget the plastic screw covers if any were removed.

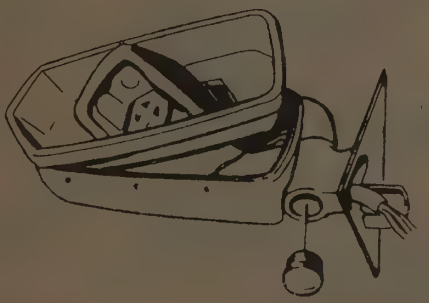

Fig. 21 Remove the mirror to the door to remove the motor — 1975-85 models

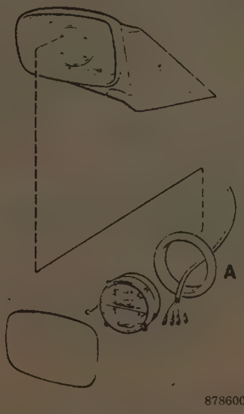

Fig. 22 Exploded view of the rearview mirror motor mounting for 1986 and later vehicles — the dust cover ("A") must be transferred to the new motor

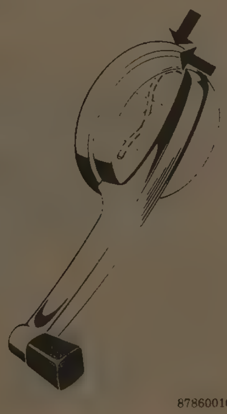

Fig. 23 Make sure you have a firm grasp on the spring clip retaining the window winder — as indicated by the arrows

200 Series

➧ **See Figures 24, 25, 26, 27, 28, 29 and 30**

1. Remove the door pocket by turning the three studs 90° and lifting off the pocket.
2. Remove the armrest. The screws may be concealed behind plastic covers.

➡If equipped with power door locks, windows, etc., disconnect and label the wires as necessary.

3. Remove the plastic housing around the inner latch release (door handle).
4. Remove the window winder. Do this by lifting up the small trim strip at the base of the winder. Remove the concealed screw and the winder may be pulled free.
5. Unscrew the lock button from the shaft.
6. The door panel is removed by gently prying the edge away from the door. Use a broad flat tool inserted between the panel and the metal of the door. The idea is to separate the clips without damage so they may be reused.

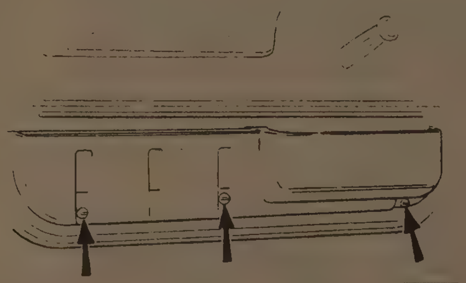

Fig. 24 Turn the clips 90 degrees to release the side pockets — 200 series

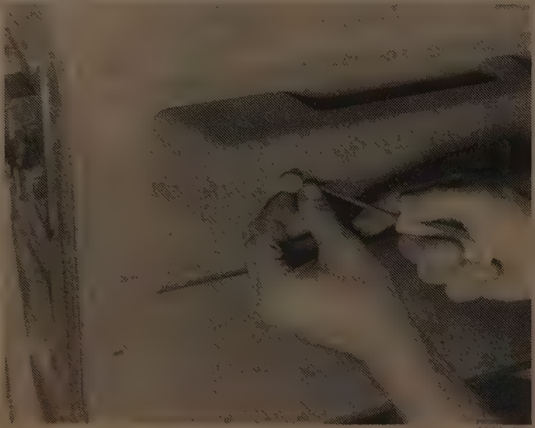

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Fig. 25 Use a small prytool to remove the plugs — take care not to gouge them or damage their edges

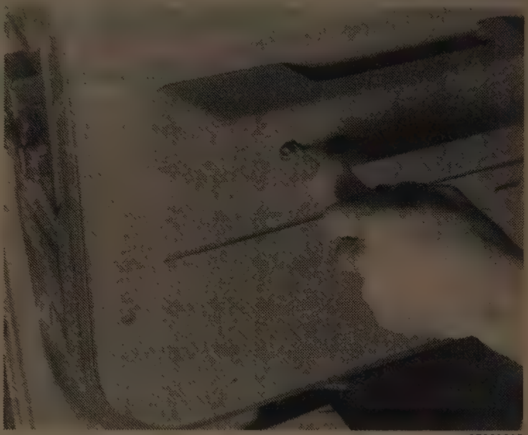

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Fig. 26 Remove the Phillips screws that secure the armrest to the door

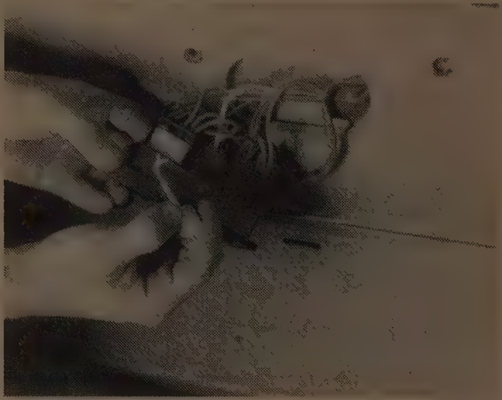

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Fig. 27 If equipped with power door locks, windows, etc., you must also disconnect these from the wires supplied through the door panel cutout

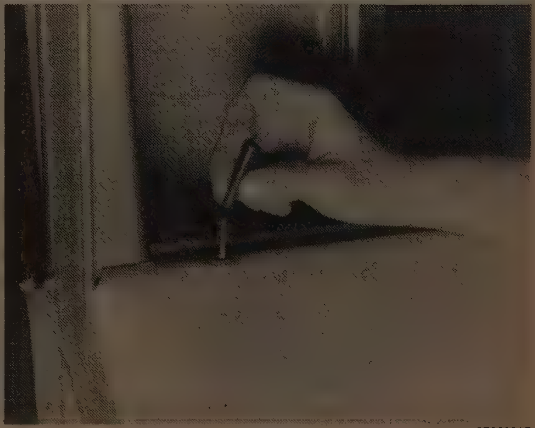

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Fig. 28 Unscrew the door locks to enable door panel removal

7. Proceed around the door until all the clips are released. Remove the door panel by lifting up to free the lip at the window edge. Be prepared to disconnect any wiring encountered within the door (courtesy lights, speakers, etc.) during removal.

➡Inside the door is a plastic moisture barrier. It may be removed for access to the door parts but it must not be ripped or torn. Should it become damaged, either replace it or repair it with waterproof tape. It must be reinstalled intact after any door repairs

8. Before reinstalling the door panel, check every clip to insure that it is properly located and not damaged. Replace any that are unusable.

To install:

9. Position the door panel onto the top of the door and seat the lip at the window rail. It may require gentle tapping to seat properly.

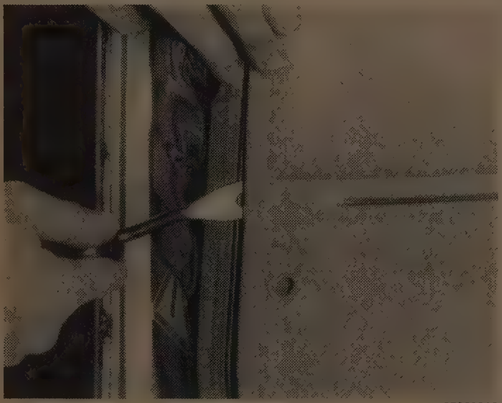
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Fig. 29 This separator tool is especially designed for this job — try not to destroy the clips. If you do, you will have to get new ones from your Volvo dealer

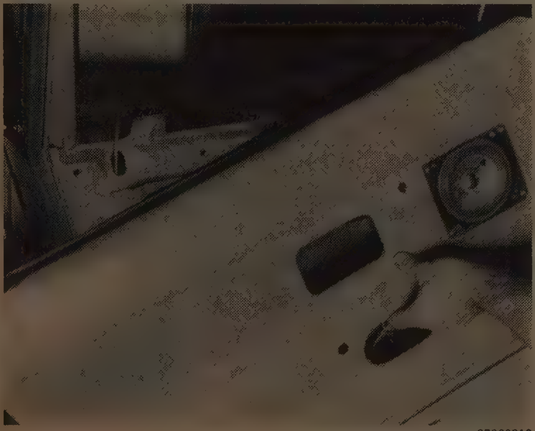
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Fig. 30 Remove the door panel, then set it in on its edge. Do not lay it flat against the back of the speakers

10. Making sure each clip aligns with its hole, proceed around the door and tap each clip into place.

11. Install the window winder, the lock button and the release handle housing.

12. Install the armrest and the door pocket.

700 Series

➧ See Figures 31 and 32

1. Carefully pry the trim strip loose from the face of handgrip. Remove the two concealed screws and remove the handgrip. If the car has manually operated windows, remove the window winder.

2. Remove the speaker grille and speaker. On 740 and 760 models, the grille is part of the longer panel held on by two concealed screws. The separate grille on the 780 is held by two screws located under the plastic trim at the lower end. Disengage wiring at the nearest connectors as access is gained.

3. On 740/760, remove the lock button. On 780 series, remove the two large plastic clips at the bottom of the door panel.

4. On 780 remove the two screws located just below the arm rest (just behind the line of the door release lever) and remove the knob from the release lever.

5. On 780 models lift the panel up and away from the door. For 740/760 models, the door panel is removed by gently prying the edge away from the door. Use a broad flat tool inserted between the panel and the metal of the door. The idea is to separate the clips without damage so they may be reused. Proceed around the door until all the clips are released. Remove the door panel by lifting up to free the lip at the window edge.

➡Inside the door is a plastic moisture barrier. It may be removed for access to the door parts but it must not be ripped or torn. Should it become damaged, replace it or repair it with waterproof tape. It must be reinstalled intact after any door repairs

6. On 780 series, remove the housing which surrounds the door release lever after the panel is removed. This will make reinstallation much easier.

7. Before reinstalling the door panel, check every clip (740 and 760) to insure that it is properly located and not damaged. Replace any that are unusable.

8. Position the door panel onto the top of the door and seat the lip at the window rail. It may require gentle tapping to seat properly. Making sure each clip aligns with its hole, proceed around the door and tap each clip into place. Connect the wiring harnesses as the components move into place.

9. For the 780, install the two large clips at the bottom of the panel and the two screws under the armrest.

10. Install the speaker and grille and connect the wiring.

11. Install the door release housing and knob on the 780 series.

12. Install the handgrip and install the cover strip. If the window winder was removed, reinstall it.

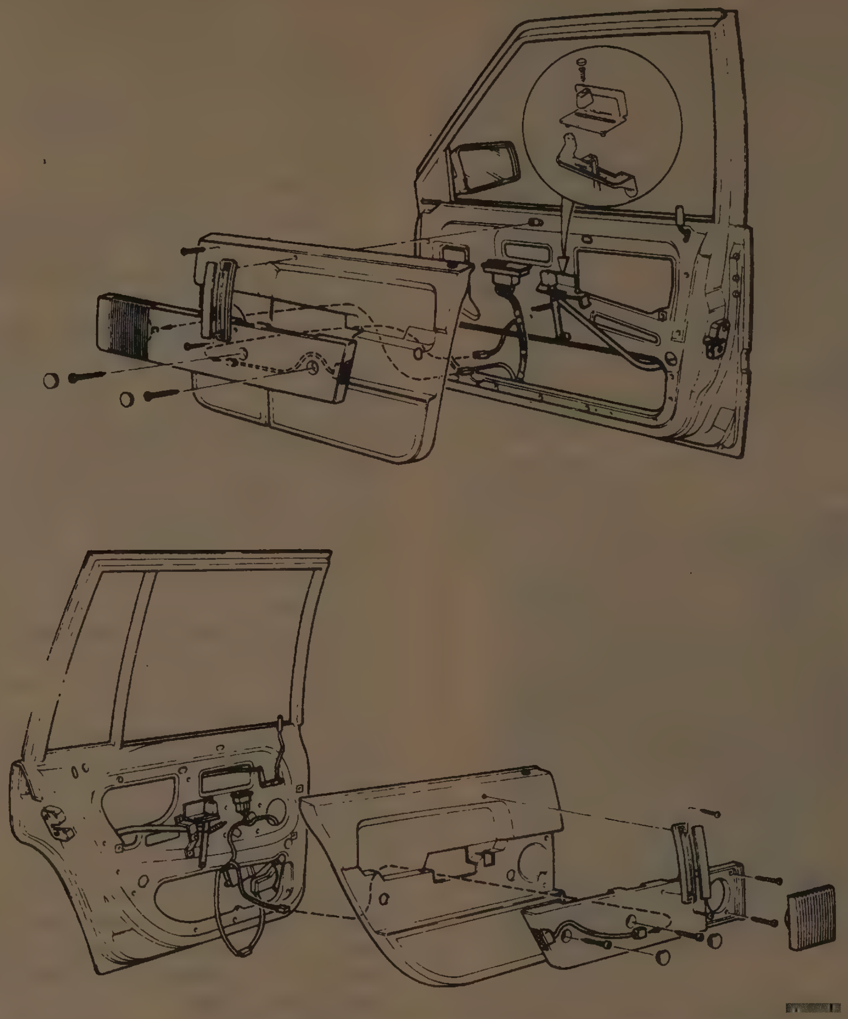

Fig. 31 Exploded view of the front a and rear door compartments mounting — 760 GLE shown; 740 doors are similar

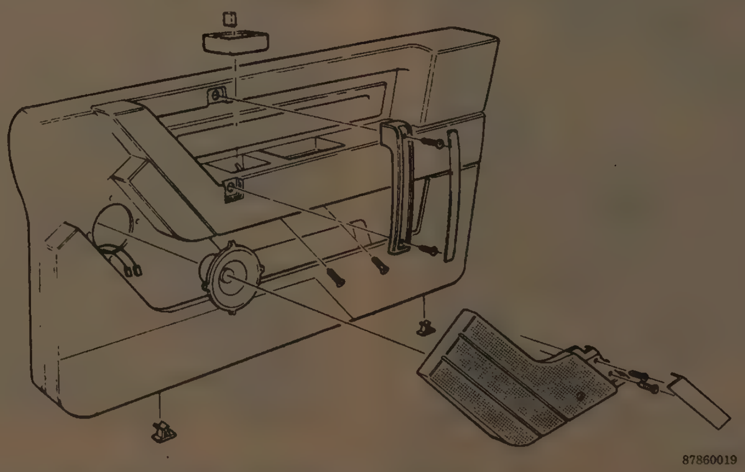

Fig. 32 Exploded view of the front door panel components — 780 series

Door Locks

REMOVAL & INSTALLATION

1800

➧ **See Figure 33**

1. Remove the inner door panel and the moisture barrier.
2. Disconnect the spring at the top of the latch linkage.
3. Remove the one screw and two nuts holing the door handle to the door and lift the handle away from the door.
4. With the handle removed, the two screws in the back of the assembly may be removed. Remove the circlip at the back of the lock cylinder and the lock may be removed from the pushbutton assembly.
5. After reassembling the lock and handle assembly, position it on the car and install the nuts and bolt. Make sure the actuating tab engages the linkage properly. Check the operation of the latch and door lock before replacing the moisture barrier and door panel.

140 and 160 Series

The door locks on these vehicles are removed simply by removing the door panel and the moisture barrier and unscrewing the retaining screw for the lock. The retaining screw is located on the rear edge of the door. When reinstalling the lock, make sure the tab on the back of the lock engages the latch properly.

200 Series

➧ **See Figures 34 and 35**

1. Remove the inner door liner and the moisture barrier.
   a. For cars with manual locks, the lock cylinder is held within the door by a clip which slides across the back of the cylinder. On 1979 and older cars, the clip can be slid free. Later cars use the same clip, but it is retained to the door with two small screws which must be removed to free the clip.
   b. On cars with power locks, the left door lock has a collar surrounding it. This electrical fitting causes all the doors to lock when the key is used in the driver's door. The retainer on this switch may be opened by prying up the plastic catch; the switch may then be removed from the lock cylinder.
2. When reinstalling, make sure the lock cylinder engages the latch mechanism properly. If replacing the lock on a 1979 or older car, the bracket must be replaced with the updated type. The new bracket stiffens the face of the door panel around the lock face.
3. If the car has power locks, make sure the switch collar is in its correct position and the clip is secure.
4. Install the moisture barrier and the inner door panel.

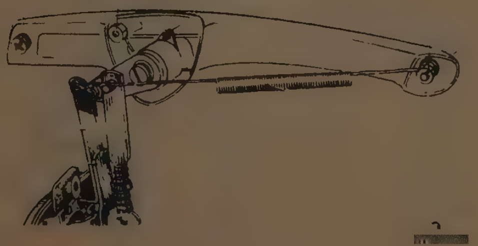

Fig. 33 Inside view of the 1800 series door handle assembly

700 Series

➧ **See Figure 36**

1. Remove the door trim pad and the moisture barrier.
2. The back of the lock cylinder has a rod connected to it. Disconnect the rod by swinging the clip away from the shaft

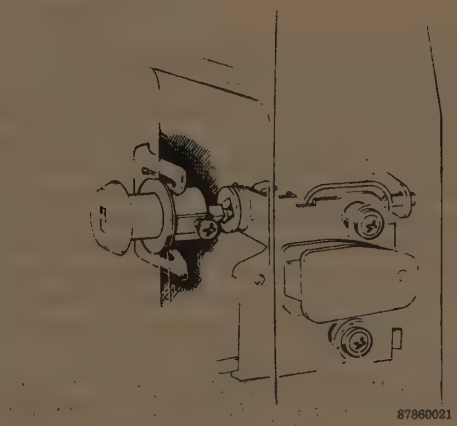

Fig. 34 The mounted (pre-1979) 200 series door lock assembly with retaining clip

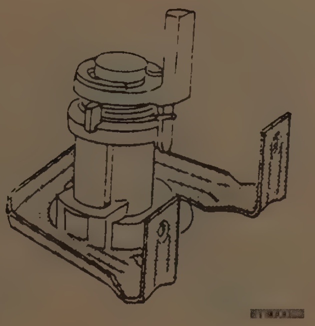

Fig. 35 Volvo updated the 200 series retaining clip for 1980 and later vehicles

and then separating the shaft from the lock. Don't break or deform the clip during removal.

3. If removing the left door lock, loosen the electrical switch around the lock by releasing the plastic catch on the collar. Remove the switch from the lock.

4. Remove the two screws holding the lock retaining bracket. Remove the bracket and remove the lock from the door.

5. When reassembling, make sure the rod is properly attached and secure. Install the retaining bracket and its two screws.

6. Install the switch on the left door lock and make sure it is properly positioned and secure.

7. Check the operation of the keylock and the power locks.

8. Install the moisture barrier and the door panel.

Door Glass and Regulator

REMOVAL & INSTALLATION

1800

1. Remove the door pad and moisture barrier.
2. In the upper center of the door, remove the two screws holding the upper window stop. Remove the stop from inside the door.
3. Fit the window winder onto the axle and wind the window to the top of its travel, then lower it about a quarter turn. Hold the glass while doing this to keep it in position.
4. Hold the glass with two hands; slide the glass rearwards and lean the top of the glass inward (toward the center of the car). This will unhook the glass from the lifting mechanism.
5. Lower the lift mechanism and lift the glass out of the door.
6. If the lifting mechanism (regulator) is to be replaced, remove the five screws holding it to the door and lift it out of the door.
7. When reinstalling, make sure that the glass is centered and runs easily in the guides. The rear guide (track) is adjustable to get a weathertight seal on the glass.
8. With all mechanical components, including the upper stop installed, test the window through the full range of motion. There should be no binding or resistance and the glass should remain square to the door during its travel.
9. Install the moisture barrier and the door pad.

140 and 160 Series

➧ See Figures 37, 38 and 39

1. Lower the window almost to its bottom position.
2. Remove the door pad and the moisture barrier.
3. Remove the screws which hold the bracket for the front vertical track and remove the bracket. (This step is omitted for rear doors.)
4. Remove the sealing strip which runs around the door frame.
5. Remove the attaching screws which hold the door frame to the door. Screws are located on both the front and rear edges of the door.
6. Lift the door frame straight up and out of the door.
7. Remove the guide roller at the upper edge of the door.
8. Support the window within the door and remove the locking springs holding the sliding rails to the lift arms. Don't allow the window to fall or get misplaced within the door.
9. Lift the window off the pins in the winder and remove the glass from the door.
10. If the regulator is to be removed from the car, remove the retaining bolts and remove the mechanism.
11. When refitting the glass into the carrier, make sure that the correct spacing is maintained. The distance (A) is 3.1 in. (80mm) for front windows and 6.7 in. (170mm) for the rear glass.
12. Reconnect the glass to the regulator pins and install the locking springs.
13. Install the upper guide roller.
14. Install the door frame and secure the front and rear retaining screws. Make sure that the glass and the frame align properly. Install the sealing strip around the frame.
15. Install the lower track bracket. Run the window through the full up and down travel and check for any signs of binding or resistance. Check also that the glass is even in its match to

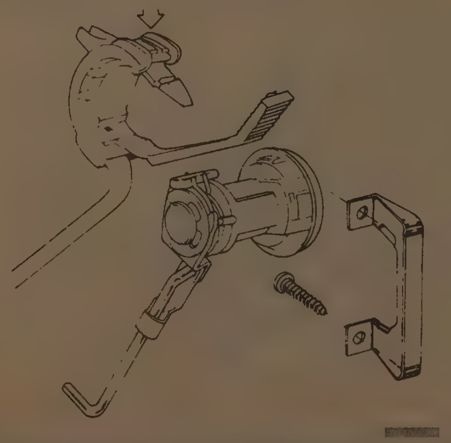

Fig. 36 Exploded view of the driver's door lock assembly

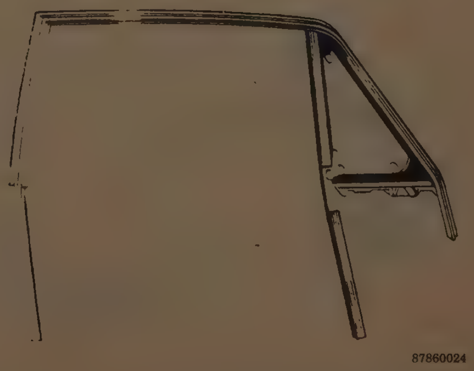

Fig. 37 The upper door frame — 140 and 164 series

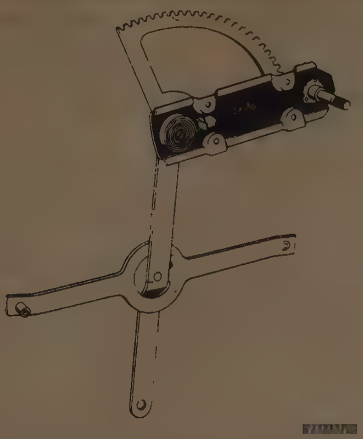

Fig. 38 To remove the glass, disconnect it from the window regulator (shown)

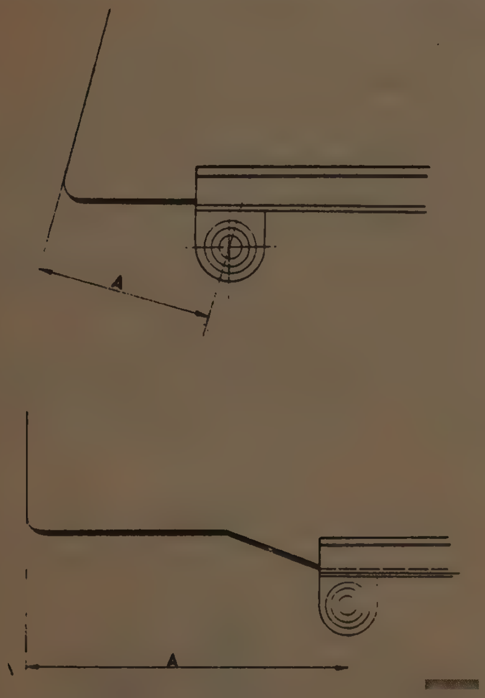

Fig. 39 Place the window glass in its lower channel with the correct spacing (see text for dimension "A") — Upper: front glass; Lower: rear glass

the door frame and is not under any abnormal tension, particularly in the closed position.

16. Install the moisture barrier and the door pad.

200 Series

MANUAL WINDOWS

➧ **See Figure 40**

1. Remove the door pad and the moisture barrier.
2. If the glass is to be replaced or removed, remove the safety catches from the pins on the two lower arms and lift out the glass. The regulator can be removed without removing the glass, but the glass must be supported within the door.
3. To remove the regulator (lift mechanism), remove the safety clips from the pins on the two lower arms. Remove the five bolts holding the regulator to the door and remove the regulator.
4. When reassembling, be careful not to scratch or knock the glass while fitting the new regulator into the door. Make certain the safety clips are firmly seated on the pins.

POWER WINDOWS

➧ **See Figures 41 and 42**

1. Remove the door pad and the moisture barrier.
2. If the glass is to be replaced or removed, remove the safety catches from the pins on the two lower arms and lift out the glass. The regulator can be removed without removing the glass, but the glass must be supported within the door.
3. Disconnect the wiring for the motor. On cars through model year 1979, the wiring must be disconnected at the fusebox. 1980 and later models may be disconnected at the armrest control panel.
4. Remove the five bolts holding the regulator and remove the regulator from the door.
5. When reinstalling, tighten the mounting screws just enough to hold position and no more. Attach the glass to the regulator with the safety clips and make sure they are properly seated.
6. Hook up the electrical connections and check the operation of the motor. Run the window up and down, checking for evenness of motion and smoothness of operation. The four

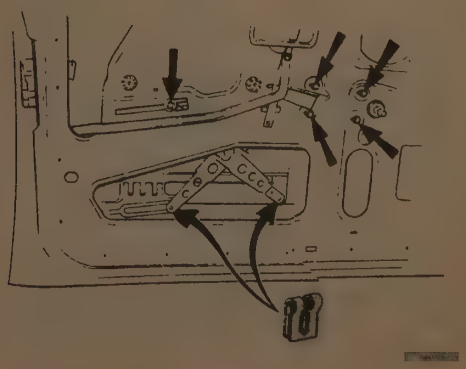

Fig. 40 The arrows indicate retaining bolts for the 200 series manual window regulator — make sure the clips are in place before installing the door panel

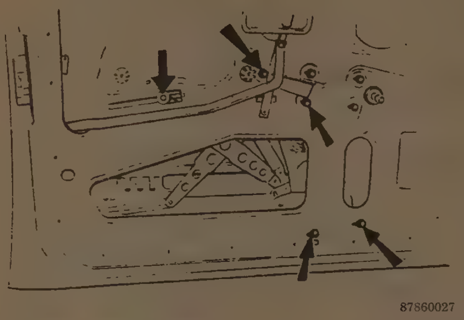

Fig. 41 Remove the retaining bolts for the power window regulator — 200 series models

mounting bolts closest to the front can be loosened to eliminate binding. Loosen the screws and operate the window up and down. As the regulator seeks its best position, tighten the bolts to hold it in place. It should take five seconds for the window to open fully.

7. Raise the window to its stopped position. Loosen the stop (at the forward edge of the regulator) and raise the window as far as it will go. Readjust the stop to mesh with the gears and tighten it in place.
8. Install the moisture barrier and the door pad.

700 Series

MANUAL WINDOWS

➧ **See Figure 43**

1. Remove the door pad and the moisture barrier.
2. If the glass is to be replaced or removed, remove the safety catches from the pins on the two lower arms and lift out the glass. It may be necessary to remove the lower channel from the glass. The regulator can be removed without removing the glass, but the glass must be supported within the door.

➡If replacing the glass in a rear door, the front window track must be removed. Loosen the two bolts in the edge of the door and the track will come free.

3. To remove the regulator (lift mechanism), remove the safety clips from the pins on the two lower arms. Remove the five bolts holding the regulator to the door and remove the regulator.
4. When reassembling, be careful not to scratch or knock the glass while fitting the new regulator into the door. Make certain the safety clips are firmly seated on the pins.
5. If installing new glass, a new piece of cushioning tape must be placed in the lower channel.
6. After reinstallation, check the travel of the glass and eliminate and binding or stiffness. Loosen the upper stop bolt (located just forward of the spring for the door release) and wind the window to its full up position. Press the bolt rearwards and retighten it.

POWER WINDOWS

➧ **See Figure 44**

✻✻WARNING

The use of the correct special tools or their equivalent is REQUIRED for this procedure.

1. Remove the door pad and the moisture barrier.
2. If the glass is to be replaced or removed, remove the safety catches from the pins on the two lower arms and lift out the glass. It may be necessary to remove the lower channel from the glass. The regulator can be removed without removing the glass, but the glass must be supported within the door.

➡If replacing the glass in a rear door, the front window track must be removed. Loosen the two bolts in the edge of the door and the track will come free.

3. Label or diagram the wiring at the motor and disconnect the wiring using Volvo tool 6351 or similar to disconnect the terminals.

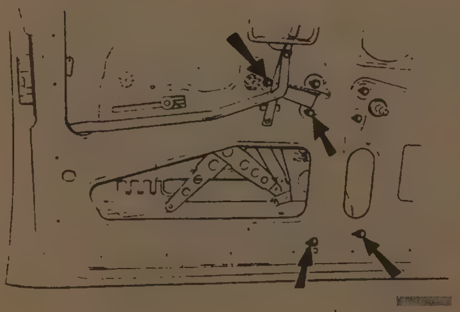

Fig. 42 Loosen only the four indicated bolts to adjust for window binding — power window equipped 200 series

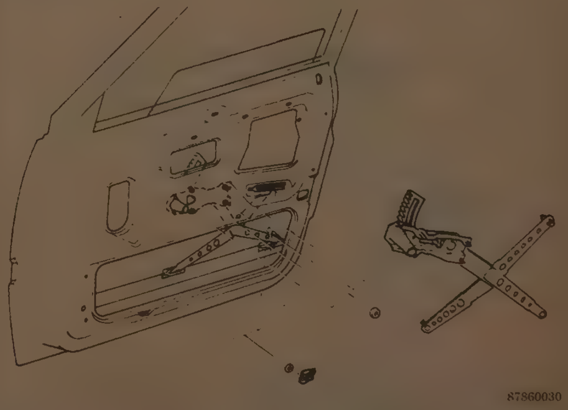

Fig. 43 Exploded view of the manual window regulator mounting — 700 series

4. To remove the regulator (lift mechanism), remove the safety clips from the pins on the two lower arms and the upper arm. Remove the four bolts holding the regulator to the door and remove the regulator.

5. When reassembling, be careful not to scratch or knock the glass while fitting the new regulator into the door. Make certain the safety clips are firmly seated on the pins.

6. If installing new glass, a new piece of cushioning tape must be placed in the lower channel.

7. Reconnect the wiring to the motor making certain that correct positioning is obtained.

8. After reinstallation, check the travel of the glass and eliminate and binding or stiffness. Loosen the upper stop bolt (located just forward of the spring for the door release) and press it forward. Wind the window to its full up position. Press the bolt rearwards and retighten it.

Seats

REMOVAL & INSTALLATION

Manual Seats

1800 SERIES, 140 AND 160 SERIES

The front seats are retained to the car by bolts (usually four) into the floor rails. In most cases these are easily seen and removed, allowing the seat and its tracks to be removed from the car. On 140 and 160 series, it may be easier to remove the bottom cushion (push down, release the clips and lift the cushion off) and then remove the seat frame from the tracks. During removal of the seat be alert for any wiring running to or under the seat which may become fouled or damaged.

If the seat itself is to be worked on out of the car, it is very helpful the support it on crates or sawhorses; the design of the seat makes it awkward to manipulate and top-heavy if set upright on the ground. Seat removal is also a good time to perform a thorough cleaning inside the car as a large open area is created. The amount of loose change found under the seats usually makes this project worthwhile.

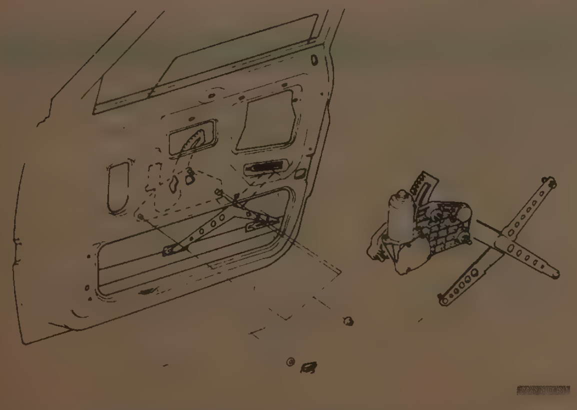

Fig. 44 Exploded view of the power mirror window regulator mounting — 700 series

When reinstalling the seat, note that the elevation and rake (tilt) of the seat may be adjusted by selecting alternate bolt holes. Once the seat has been examined and the mounting system is understood, a little experimentation can yield a most comfortable seating position.

200 AND 700 SERIES

➧ **See Figures 45, 46, 47 and 48**

The front seat and its rails may be unbolted from the floor of the car. Many cars have heated seats; it will be necessary to disconnect the wiring harness for this system before removing the seat.

On the early 760 series, it is necessary to remove the seat belt anchor from the side of the seat. Remove the screw in the rear of the side pocket, lift the pocket out of the way and remove the seat belt bolt.

After all the retaining bolts are removed, the front seats in the 700 series are removed by sliding the seat to the rear of its track and lifting upwards to free the seat from the catches.

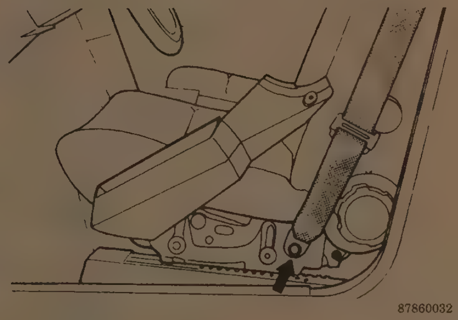

Fig. 45 Remove the seat belt retaining bolt (indicated by the arrow) — early 760 models

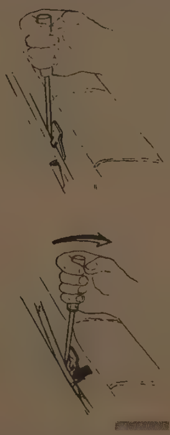

Fig. 46 Disconnect the rear retaining clips to remove the rear seat — 200 series shown. 700 series is similar

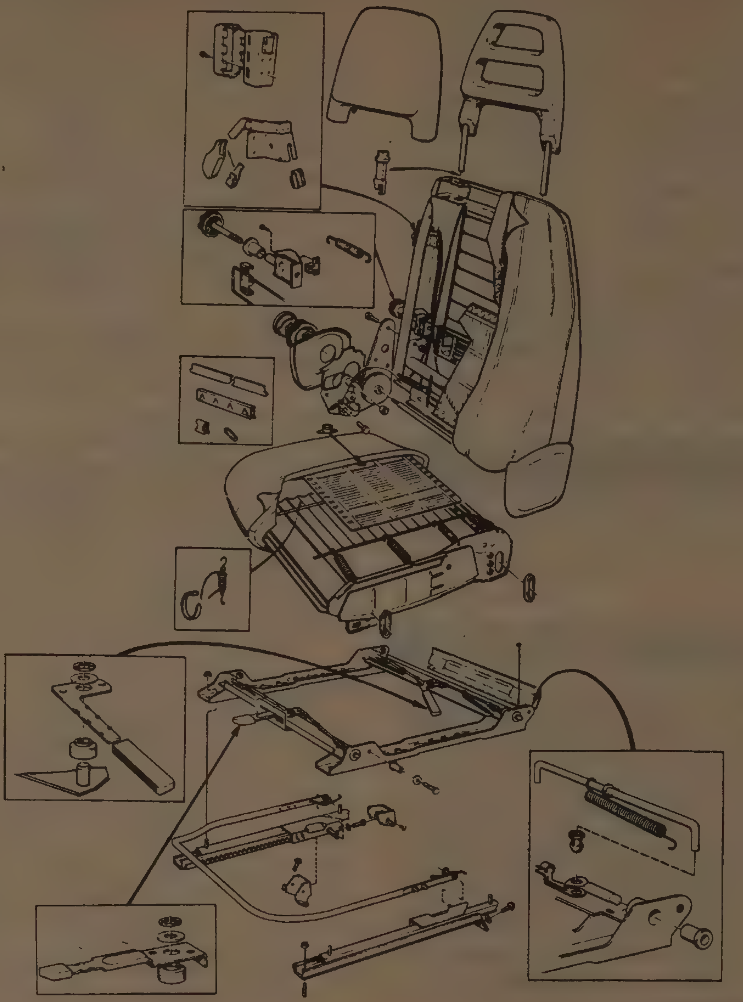

Fig. 47 Exploded view of the manual front seat and mounting assembly — 200 series

The rear seat cushion is removed by pressing down directly over the retaining clips (freeing the hook from the loop) and lifting the cushion clear. The rear seat backrest is held by catches which hold the upper bar in place. These catches can be released with a prytool; don't bend them anymore than needed or reassembly will be very difficult.

When reassembling the rear seat, always install the backrest first. Make sure that every clip engages properly and is firmly closed.

Power Seats

➧ See Figure 49

1. Disconnect the negative battery cable.
2. Remove the plastic rail covers as necessary and remove the front bolts holding the seat tracks to the car. Loosen but do not remove the bolts at the rear of the tracks.
3. Gently elevate the front of the seat; identify and label the wiring running to the seat components. Disengage the seat wiring connectors.

✲✲WARNING

Do not disconnect any wiring for other components. Many other units may be found under the seat — leave them connected at all times.

4. Remove the rear mounting bolts and lift the seat clear of the car. It will be heavy — an assistant inside the car can ease removal.
5. Either support the seat on crates or a clean workbench or place the seat on a clean blanket to protect it.

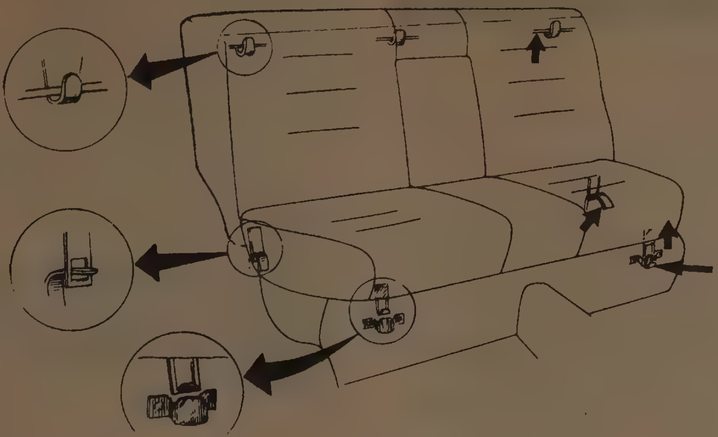

Fig. 48 Location of the rear seat retaining clips — 700 series

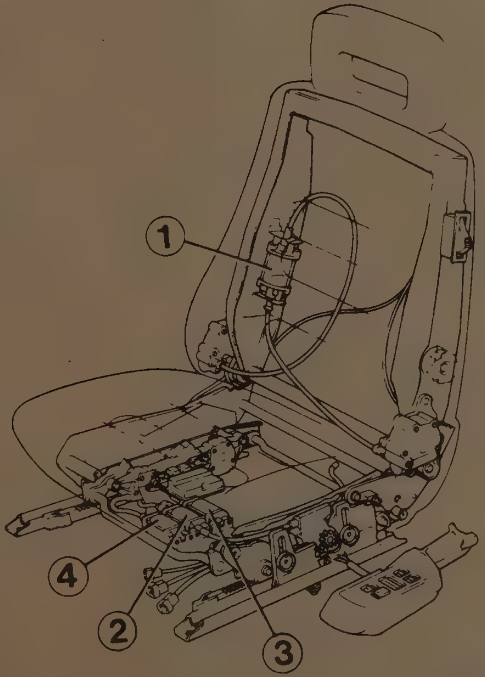

Fig. 49 Cutaway view of the 780 series power front seat assembly — 1: backrest tilt motor; 2: fore/aft motor; 3: front section elevation motor; 4: rear section elevation motor

Power Seat Motors

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the seat from the car following the procedure outlined previously.
3. Turn the seat upside down and remove the four screws holding the motor to its bracket.
4. Lift out the motor and remove the drive cable from the motor. Use care not to kink or crease the cable.
5. Disconnect the wiring to the motor. On 780 models, this may require removing the pins from the connector case. To remove the fore-and-aft motor on the 780, remove the middle connector from the control unit. Open the connector and remove the wiring at the terminals.
6. When reinstalling, make sure the wiring is properly located and secure in its connector. Fit the cable into the motor and install the retainer if any.
7. Install the motor and final check the wiring. Make sure it is out of the way of any moving parts.
8. Install the seat in the car, connect the wiring harnesses and connect the negative battery cable. Check the operation of the seat.

➡The motor controlling the seatback tilt is within the seatback. Access to this motor involves removal of the seatback and disassembly of upholstery pieces. If trouble is experienced with this motor, repair by trained personnel is recommended.

How to Remove Stains from Fabric Interior

For rest results, spots and stains should be removed as soon as possible. Never use gasoline, lacquer thinner, acetone, nail polish remover or bleach. Use a 3′ x 3″ piece of cheesecloth. Squeeze most of the liquid from the fabric and wipe the stained fabric from the outside of the stain toward the center with a lifting motion. Turn the cheesecloth as soon as one side becomes soiled. When using water to remove a stain, be sure to wash the entire section after the spot has been removed to avoid water stains. Encrusted spots can be broken up with a dull knife and vacuumed before removing the stain.

Type of Stain	How to Remove It
Surface spots	Brush the spots out with a small hand brush or use a commercial preparation such as K2R to lift the stain.
Mildew	Clean around the mildew with warm suds. Rinse in cold water and soak the mildew area in a solution of 1 part table salt and 2 parts water. Wash with upholstery cleaner.
Water stains	Water stains in fabric materials can be removed with a solution made from 1 cup of table salt dissolved in 1 quart of water. Vigorously scrub the solution into the stain and rinse with clear water. Water stains in nylon or other synthetic fabrics should be removed with a commercial type spot remover.
Chewing gum, tar, crayons, shoe polish (greasy stains)	Do not use a cleaner that will soften gum or tar. Harden the deposit with an ice cube and scrape away as much as possible with a dull knife. Moisten the remainder with cleaning fluid and scrub clean.
Ice cream, candy	Most candy has a sugar base and can be removed with a cloth wrung out in warm water. Oily candy, after cleaning with warm water, should be cleaned with upholstery cleaner. Rinse with warm water and clean the remainder with cleaning fluid.
Wine, alcohol, egg, milk, soft drink (non-greasy stains)	Do not use soap. Scrub the stain with a cloth wrung out in warm water. Remove the remainder with cleaning fluid.
Grease, oil, lipstick, butter and related stains	Use a spot remover to avoid leaving a ring. Work from the outisde of the stain to the center and dry with a clean cloth when the spot is gone.
Headliners (cloth)	Mix a solution of warm water and foam upholstery cleaner to give thick suds. Use only foam—liquid may streak or spot. Clean the entire headliner in one operation using a circular motion with a natural sponge.
Headliner (vinyl)	Use a vinyl cleaner with a sponge and wipe clean with a dry cloth.
Seats and door panels	Mix 1 pint upholstery cleaner in 1 gallon of water. Do not soak the fabric around the buttons.
Leather or vinyl fabric	Use a multi-purpose cleaner full strength and a stiff brush. Let stand 2 minutes and scrub thoroughly. Wipe with a clean, soft rag.
Nylon or synthetic fabrics	For normal stains, use the same procedures you would for washing cloth upholstery. If the fabric is extremely dirty, use a multi-purpose cleaner full strength with a stiff scrub brush. Scrub thoroughly in all directions and wipe with a cotton towel or soft rag.

87860C01

General Conversion Table

Multiply By	To Convert	To	
	LENGTH		
2.54	Inches	Centimeters	.3937
25.4	Inches	Millimeters	.03937
30.48	Feet	Centimeters	.0328
.304	Feet	Meters	3.28
.914	Yards	Meters	1.094
1.609	Miles	Kilometers	.621
	VOLUME		
.473	Pints	Liters	2.11
.946	Quarts	Liters	1.06
3.785	Gallons	Liters	.264
.016	Cubic inches	Liters	61.02
16.39	Cubic inches	Cubic cms.	.061
28.3	Cubic feet	Liters	.0353
	MASS (Weight)		
28.35	Ounces	Grams	.035
.4536	Pounds	Kilograms	2.20
—	To obtain	From	Multiply by

Multiply By	To Convert	To	
	AREA		
.645	Square inches	Square cms.	.155
.836	Square yds.	Square meters	1.196
	FORCE		
4.448	Pounds	Newtons	.225
.138	Ft./lbs.	Kilogram/meters	7.23
1.36	Ft. lbs.	Newton-meters	.737
.112	In./lbs.	Newton-meters	8.844
	PRESSURE		
.068	Psi	Atmospheres	14.7
6.89	Psi	Kilopascals	.145
	OTHER		
1.104	Horsepower (DIN)	Horsepower (SAE)	.986
.746	Horsepower (SAE)	Kilowatts (KW)	1.34
1.60	Mph	Km/h	.625
.425	Mpg	Km/1	2.35
—	To obtain	From	Multiply by

87860C02

Tap Drill Sizes

National Coarse or U.S.S.		
Screw & Tap Size	**Threads Per Inch**	**Use Drill Number**
No 5	40	39
No 6	32	36
No 8	32	29
No 10	24	25
No 12	24	17
1/4	20	8
5/16	18	F
3/8	16	5/16
7/16	14	U
1/2	13	27/64
9/16	12	31/64
5/8	11	17/32
3/4	10	21/32
7/8	9	49/64

National Coarse or U.S.S.		
Screw & Tap Size	**Threads Per Inch**	**Use Drill Number**
1	8	7/8
1 1/8	7	63/64
1 1/4	7	1 7/64
1 1/2	6	1 11/32

National Fine or S.A.E.		
Screw & Tap Size	**Threads Per Inch**	**Use Drill Number**
No. 5	44	37
No. 6	40	33
No. 8	36	29
No. 10	32	21

National Fine or S.A.E.		
Screw & Tap Size	**Threads Per Inch**	**Use Drill Number**
No. 12	28	15
1/4	28	3
5/16	24	1
3/8	24	Q
7/16	20	W
1/2	20	29/64
9/16	18	33/64
5/8	18	37/64
3/4	16	11/16
7/8	14	13/16
1 1/8	12	1 3/64
1 1/4	12	1 11/64
1 1/2	12	1 27/64

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Drill Sizes In Decimal Equivalents

Inch	Decimal	Wire	mm	Inch	Decimal	Wire	mm	Inch	Decimal	Wire & Letter	mm	Inch	Decimal	Letter	mm	Inch	Decimal	mm
1/64	.0156		.39		.0730	49			.1614		4.1		.2717		6.9		.4331	11.0
	.0157		.4		.0748		1.9		.1654		4.2		.2720	I		7/16	.4375	11.11
	.0160	78			.0760	48			.1660	19			.2756		7.0		.4528	11.5
	.0165		.42		.0768		1.95		.1673		4.25		.2770	J		29/64	.4531	11.51
	.0173		.44	5/64	.0781		1.98		.1693		4.3		.2795		7.1	15/32	.4688	11.90
	.0177		.45		.0785	47			.1695	18			.2810	K			.4724	12.0
	.0180	77			.0787		2.0	11/64	.1719		4.36	9/32	.2812		7.14	31/64	.4844	12.30
	.0181		.46		.0807		2.05		.1730	17			.2835		7.2		.4921	12.5
	.0189		.48		.0810	46			.1732		4.4		.2854		7.25	1/2	.5000	12.70
	.0197		.5		.0820	45			.1770	16			.2874		7.3		.5118	13.0
	.0200	76			.0827		2.1		.1772		4.5		.2900	L		33/64	.5156	13.09
	.0210	75			.0846		2.15		.1800	15			.2913		7.4	17/32	.5312	13.49
	.0217		.55		.0860	44			.1811		4.6		.2950	M			.5315	13.5
	.0225	74			.0866		2.2		.1820	14			.2953		7.5	35/64	.5469	13.89
	.0236		.6		.0886		2.25		.1850	13		19/64	.2969		7.54		.5512	14.0
	.0240	73			.0890	43			.1850		4.7		.2992		7.6	9/16	.5625	14.28
	.0250	72			.0906		2.3		.1870		4.75		.3020	N			.5709	14.5
	.0256		.65		.0925		2.35	3/16	.1875		4.76		.3031		7.7	37/64	.5781	14.68
	.0260	71			.0935	42			.1890		4.8		.3051		7.75		.5906	15.0
	.0276		.7	3/32	.0938		2.38		.1890	12			.3071		7.8	19/32	.5938	15.08
	.0280	70			.0945		2.4		.1910	11			.3110		7.9	39/64	.6094	15.47
	.0292	69			.0960	41			.1929		4.9	5/16	.3125		7.93		.6102	15.5
	.0295		.75		.0965		2.45		.1935	10			.3150		8.0	5/8	.6250	15.87
	.0310	68			.0980	40			.1960	9			.3160	O			.6299	16.0
1/32	.0312		.79		.0981		2.5		.1969		5.0		.3189		8.1	41/64	.6406	16.27
	.0315		.8		.0995	39			.1990	8			.3228		8.2		.6496	16.5
	.0320	67			.1015	38			.2008		5.1		.3230	P		21/32	.6562	16.66
	.0330	66			.1024		2.6		.2010	7			.3248		8.25		.6693	17.0
	.0335		.85		.1040	37		13/64	.2031		5.16		.3268		8.3	43/64	.6719	17.06
	.0350	65			.1063		2.7		.2040	6		21/64	.3281		8.33	11/16	.6875	17.46
	.0354		.9		.1065	36			.2047		5.2		.3307		8.4		.6890	17.5
	.0360	64			.1083		2.75		.2055	5			.3320	Q		45/64	.7031	17.85
	.0370	63		7/64	.1094		2.77		.2067		5.25		.3346		8.5		.7087	18.0
	.0374		.95		.1100	35			.2087		5.3		.3386		8.6	23/32	.7188	18.25
	.0380	62			.1102		2.8		.2090	4			.3390	R			.7283	18.5
	.0390	61			.1110	34			.2126		5.4		.3425		8.7	47/64	.7344	18.65
	.0394		1.0		.1130	33			.2130	3		11/32	.3438		8.73		.7480	19.0
	.0400	60			.1142		2.9		.2165		5.5		.3445		8.75	3/4	.7500	19.05
	.0410	59			.1160	32		7/32	.2188		5.55		.3465		8.8	49/64	.7656	19.44
	.0413		1.05		.1181		3.0		.2205		5.6		.3480	S			.7677	19.5
	.0420	58			.1200	31			.2210	2			.3504		8.9	25/32	.7812	19.84
	.0430	57			.1220		3.1		.2244		5.7		.3543		9.0		.7874	20.0
	.0433		1.1	1/8	.1250		3.17		.2264		5.75		.3580	T		51/64	.7969	20.24
	.0453		1.15		.1260		3.2		.2280	1			.3583		9.1		.8071	20.5
	.0465	56			.1280		3.25		.2283		5.8	23/64	.3594		9.12	13/16	.8125	20.63
3/64	.0469		1.19		.1285	30			.2323		5.9		.3622		9.2		.8268	21.0
	.0472		1.2		.1299		3.3		.2340	A			.3642		9.25	53/64	.8281	21.03
	.0492		1.25		.1339		3.4	15/64	.2344		5.95		.3661		9.3	27/32	.8438	21.43
	.0512		1.3		.1360	29			.2362		6.0		.3680	U			.8465	21.5
	.0520	55			.1378		3.5		.2380	B			.3701		9.4	55/64	.8594	21.82
	.0531		1.35		.1405	28			.2402		6.1		.3740		9.5		.8661	22.0
	.0550	54		9/64	.1406		3.57		.2420	C		3/8	.3750		9.52	7/8	.8750	22.22
	.0551		1.4		.1417		3.6		.2441		6.2		.3770	V			.8858	22.5
	.0571		1.45		.1440	27			.2460	D			.3780		9.6	57/64	.8906	22.62
	.0591		1.5		.1457		3.7		.2461		6.25		.3819		9.7		.9055	23.0
	.0595	53			.1470	26			.2480		6.3		.3839		9.75	29/32	.9062	23.01
	.0610		1.55		.1476		3.75	1/4	.2500	E	6.35		.3858		9.8	59/64	.9219	23.41
1/16	.0625		1.59		.1495	25			.2520		6.		.3860	W			.9252	23.5
	.0630		1.6		.1496		3.8		.2559		6.5		.3898		9.9	15/16	.9375	23.81
	.0635	52			.1520	24			.2570	F		25/64	.3906		9.92		.9449	24.0
	.0650		1.65		.1535		3.9		.2598		6.6		.3937		10.0	61/64	.9531	24.2
	.0669		1.7		.1540	23			.2610	G			.3970	X			.9646	24.5
	.0670	51		5/32	.1562		3.96		.2638		6.7		.4040	Y		31/64	.9688	24.6
	.0689		1.75		.1570	22		17/64	.2656		6.74	13/32	.4062		10.31		.9843	25.0
	.0700	50			.1575		4.0		.2657		6.75		.4130	Z		63/64	.9844	25.0
	.0709		1.8		.1590	21			.2660	H			.4134		10.5	1	1.0000	25.4
	.0728		1.85		.1610	20			.2677		6.8	27/64	.4219		10.71			

[illegible]

GLOSSARY

AIR/FUEL RATIO: The ratio of air-to-gasoline by weight in the fuel mixture drawn into the engine.

AIR INJECTION: One method of reducing harmful exhaust emissions by injecting air into each of the exhaust ports of an engine. The fresh air entering the hot exhaust manifold causes any remaining fuel to be burned before it can exit the tailpipe.

ALTERNATOR: A device used for converting mechanical energy into electrical energy.

AMMETER: An instrument, calibrated in amperes, used to measure the flow of an electrical current in a circuit. Ammeters are always connected in series with the circuit being tested.

AMPERE: The rate of flow of electrical current present when one volt of electrical pressure is applied against one ohm of electrical resistance.

ANALOG COMPUTER: Any microprocessor that uses similar (analogous) electrical signals to make its calculations.

ARMATURE: A laminated, soft iron core wrapped by a wire that converts electrical energy to mechanical energy as in a motor or relay. When rotated in a magnetic field, it changes mechanical energy into electrical energy as in a generator.

ATMOSPHERIC PRESSURE: The pressure on the Earth's surface caused by the weight of the air in the atmosphere. At sea level, this pressure is 14.7 psi at 32°F (101 kPa at 0°C).

ATOMIZATION: The breaking down of a liquid into a fine mist that can be suspended in air.

AXIAL PLAY: Movement parallel to a shaft or bearing bore.

BACKFIRE: The sudden combustion of gases in the intake or exhaust system that results in a loud explosion.

BACKLASH: The clearance or play between two parts, such as meshed gears.

BACKPRESSURE: Restrictions in the exhaust system that slow the exit of exhaust gases from the combustion chamber.

BAKELITE: A heat resistant, plastic insulator material commonly used in printed circuit boards and transistorized components.

BALL BEARING: A bearing made up of hardened inner and outer races between which hardened steel balls roll.

BALLAST RESISTOR: A resistor in the primary ignition circuit that lowers voltage after the engine is started to reduce wear on ignition components.

BEARING: A friction reducing, supportive device usually located between a stationary part and a moving part.

BIMETAL TEMPERATURE SENSOR: Any sensor or switch made of two dissimilar types of metal that bend when heated or cooled due to the different expansion rates of the alloys. These types of sensors usually function as an on/off switch.

BLOWBY: Combustion gases, composed of water vapor and unburned fuel, that leak past the piston rings into the crankcase during normal engine operation. These gases are removed by the PCV system to prevent the buildup of harmful acids in the crankcase.

BRAKE PAD: A brake shoe and lining assembly used with disc brakes.

BRAKE SHOE: The backing for the brake lining. The term is, however, usually applied to the assembly of the brake backing and lining.

BUSHING: A liner, usually removable, for a bearing; an anti-friction liner used in place of a bearing.

CALIPER: A hydraulically activated device in a disc brake system, which is mounted straddling the brake rotor (disc). The caliper contains at least one piston and two brake pads. Hydraulic pressure on the piston(s) forces the pads against the rotor.

CAMSHAFT: A shaft in the engine on which are the lobes (cams) which operate the valves. The camshaft is driven by the crankshaft, via a belt, chain or gears, at one half the crankshaft speed.

CAPACITOR: A device which stores an electrical charge.

CARBON MONOXIDE (CO): A colorless, odorless gas given off as a normal byproduct of combustion. It is poisonous and extremely dangerous in confined areas, building up slowly to toxic levels without warning if adequate ventilation is not available.

CARBURETOR: A device, usually mounted on the intake manifold of an engine, which mixes the air and fuel in the proper proportion to allow even combustion.

CATALYTIC CONVERTER: A device installed in the exhaust system, like a muffler, that converts harmful byproducts of combustion into carbon dioxide and water vapor by means of a heat-producing chemical reaction.

CENTRIFUGAL ADVANCE: A mechanical method of advancing the spark timing by using flyweights in the distributor that react to centrifugal force generated by the distributor shaft rotation.

CHECK VALVE: Any one-way valve installed to permit the flow of air, fuel or vacuum in one direction only.

CHOKE: A device, usually a moveable valve, placed in the intake path of a carburetor to restrict the flow of air.

CIRCUIT: Any unbroken path through which an electrical current can flow. Also used to describe fuel flow in some instances.

CIRCUIT BREAKER: A switch which protects an electrical circuit from overload by opening the circuit when the current flow exceeds a predetermined level. Some circuit breakers must be reset manually, while most reset automatically.

COIL (IGNITION): A transformer in the ignition circuit which steps up the voltage provided to the spark plugs.

COMBINATION MANIFOLD: An assembly which includes both the intake and exhaust manifolds in one casting.

COMBINATION VALVE: A device used in some fuel systems that routes fuel vapors to a charcoal storage canister instead of venting them into the atmosphere. The valve relieves fuel tank pressure and allows fresh air into the tank as the fuel level drops to prevent a vapor lock situation.

COMPRESSION RATIO: The comparison of the total volume of the cylinder and combustion chamber with the piston at BDC and the piston at TDC.

CONDENSER: 1. An electrical device which acts to store an electrical charge, preventing voltage surges. 2. A radiator-like device in the air conditioning system in which refrigerant gas condenses into a liquid, giving off heat.

CONDUCTOR: Any material through which an electrical current can be transmitted easily.

CONTINUITY: Continuous or complete circuit. Can be checked with an ohmmeter.

COUNTERSHAFT: An intermediate shaft which is rotated by a mainshaft and transmits, in turn, that rotation to a working part.

CRANKCASE: The lower part of an engine in which the crankshaft and related parts operate.

CRANKSHAFT: The main driving shaft of an engine which receives reciprocating motion from the pistons and converts it to rotary motion.

CYLINDER: In an engine, the round hole in the engine block in which the piston(s) ride.

CYLINDER BLOCK: The main structural member of an engine in which is found the cylinders, crankshaft and other principal parts.

CYLINDER HEAD: The detachable portion of the engine, usually fastened to the top of the cylinder block and containing all or most of the combustion chambers. On overhead valve engines, it contains the valves and their operating parts. On overhead cam engines, it contains the camshaft as well.

DEAD CENTER: The extreme top or bottom of the piston stroke.

DETONATION: An unwanted explosion of the air/fuel mixture in the combustion chamber caused by excess heat and compression, advanced timing, or an overly lean mixture. Also referred to as "ping".

DIAPHRAGM: A thin, flexible wall separating two cavities, such as in a vacuum advance unit.

DIESELING: A condition in which hot spots in the combustion chamber cause the engine to run on after the key is turned off.

DIFFERENTIAL: A geared assembly which allows the transmission of motion between drive axles, giving one axle the ability to turn faster than the other.

DIODE: An electrical device that will allow current to flow in one direction only.

DISC BRAKE: A hydraulic braking assembly consisting of a brake disc, or rotor, mounted on an axle, and a caliper assembly containing, usually two brake pads which are activated by hydraulic pressure. The pads are forced against the sides of the disc, creating friction which slows the vehicle.

DISTRIBUTOR: A mechanically driven device on an engine which is responsible for electrically firing the spark plug at a predetermined point of the piston stroke.

DOWEL PIN: A pin, inserted in mating holes in two different parts allowing those parts to maintain a fixed relationship.

DRUM BRAKE: A braking system which consists of two brake shoes and one or two wheel cylinders, mounted on a fixed backing plate, and a brake drum, mounted on an axle, which revolves around the assembly.

DWELL: The rate, measured in degrees of shaft rotation, at which an electrical circuit cycles on and off.

ELECTRONIC CONTROL UNIT (ECU): Ignition module, module, amplifier or igniter. See Module for definition.

ELECTRONIC IGNITION: A system in which the timing and firing of the spark plugs is controlled by an electronic control unit, usually called a module. These systems have no points or condenser.

END-PLAY: The measured amount of axial movement in a shaft.

ENGINE: A device that converts heat into mechanical energy.

EXHAUST MANIFOLD: A set of cast passages or pipes which conduct exhaust gases from the engine.

FEELER GAUGE: A blade, usually metal, of precisely predetermined thickness, used to measure the clearance between two parts.

FIRING ORDER: The order in which combustion occurs in the cylinders of an engine. Also the order in which spark is distributed to the plugs by the distributor.

FLOODING: The presence of too much fuel in the intake manifold and combustion chamber which prevents the air/fuel mixture from firing, thereby causing a no-start situation.

FLYWHEEL: A disc shaped part bolted to the rear end of the crankshaft. Around the outer perimeter is affixed the ring gear. The starter drive engages the ring gear, turning the flywheel, which rotates the crankshaft, imparting the initial starting motion to the engine.

FOOT POUND (ft. lbs. or sometimes, ft.lb.): The amount of energy or work needed to raise an item weighing one pound, a distance of one foot.

FUSE: A protective device in a circuit which prevents circuit overload by breaking the circuit when a specific amperage is present. The device is constructed around a strip or wire of a lower amperage rating than the circuit it is designed to protect. When an amperage higher than that stamped on the fuse is present in the circuit, the strip or wire melts, opening the circuit.

GEAR RATIO: The ratio between the number of teeth on meshing gears.

GENERATOR: A device which converts mechanical energy into electrical energy.

HEAT RANGE: The measure of a spark plug's ability to dissipate heat from its firing end. The higher the heat range, the hotter the plug fires.

HUB: The center part of a wheel or gear.

HYDROCARBON (HC): Any chemical compound made up of hydrogen and carbon. A major pollutant formed by the engine as a byproduct of combustion.

HYDROMETER: An instrument used to measure the specific gravity of a solution.

INCH POUND (inch lbs.; sometimes in.lb. or in. lbs.): One twelfth of a foot pound.

INDUCTION: A means of transferring electrical energy in the form of a magnetic field. Principle used in the ignition coil to increase voltage.

INJECTOR: A device which receives metered fuel under relatively low pressure and is activated to inject the fuel into the engine under relatively high pressure at a predetermined time.

INPUT SHAFT: The shaft to which torque is applied, usually carrying the driving gear or gears.

INTAKE MANIFOLD: A casting of passages or pipes used to conduct air or a fuel/air mixture to the cylinders.

JOURNAL: The bearing surface within which a shaft operates.

KEY: A small block usually fitted in a notch between a shaft and a hub to prevent slippage of the two parts.

MANIFOLD: A casting of passages or set of pipes which connect the cylinders to an inlet or outlet source.

MANIFOLD VACUUM: Low pressure in an engine intake manifold formed just below the throttle plates. Manifold vacuum is highest at idle and drops under acceleration.

MASTER CYLINDER: The primary fluid pressurizing device in a hydraulic system. In automotive use, it is found in brake and hydraulic clutch systems and is pedal activated, either directly or, in a power brake system, through the power booster.

MODULE: Electronic control unit, amplifier or igniter of solid state or integrated design which controls the current flow in the ignition primary circuit based on input from the pick-up coil. When the module opens the primary circuit, high secondary voltage is induced in the coil.

NEEDLE BEARING: A bearing which consists of a number (usually a large number) of long, thin rollers.

OHM:(Ω) The unit used to measure the resistance of conductor-to-electrical flow. One ohm is the amount of resistance that limits current flow to one ampere in a circuit with one volt of pressure.

OHMMETER: An instrument used for measuring the resistance, in ohms, in an electrical circuit.

OUTPUT SHAFT: The shaft which transmits torque from a device, such as a transmission.

OVERDRIVE: A gear assembly which produces more shaft revolutions than that transmitted to it.

OVERHEAD CAMSHAFT (OHC): An engine configuration in which the camshaft is mounted on top of the cylinder head and operates the valve either directly or by means of rocker arms.

OVERHEAD VALVE (OHV): An engine configuration in which all of the valves are located in the cylinder head and the camshaft is located in the cylinder block. The camshaft operates the valves via lifters and pushrods.

OXIDES OF NITROGEN (NOx): Chemical compounds of nitrogen produced as a byproduct of combustion. They combine with hydrocarbons to produce smog.

OXYGEN SENSOR: Used with the feedback system to sense the presence of oxygen in the exhaust gas and signal the computer which can reference the voltage signal to an air/fuel ratio.

PINION: The smaller of two meshing gears.

PISTON RING: An open-ended ring which fits into a groove on the outer diameter of the piston. Its chief function is to form a seal between the piston and cylinder wall. Most automotive pistons have three rings: two for compression sealing; one for oil sealing.

PRELOAD: A predetermined load placed on a bearing during assembly or by adjustment.

PRIMARY CIRCUIT: The low voltage side of the ignition system which consists of the ignition switch, ballast resistor or resistance wire, bypass, coil, electronic control unit and pick-up coil as well as the connecting wires and harnesses.

PRESS FIT: The mating of two parts under pressure, due to the inner diameter of one being smaller than the outer diameter of the other, or vice versa; an interference fit.

RACE: The surface on the inner or outer ring of a bearing on which the balls, needles or rollers move.

REGULATOR: A device which maintains the amperage and/or voltage levels of a circuit at predetermined values.

RELAY: A switch which automatically opens and/or closes a circuit.

RESISTANCE: The opposition to the flow of current through a circuit or electrical device, and is measured in ohms. Resistance is equal to the voltage divided by the amperage.

RESISTOR: A device, usually made of wire, which offers a preset amount of resistance in an electrical circuit.

RING GEAR: The name given to a ring-shaped gear attached to a differential case, or affixed to a flywheel or as part of a planetary gear set.

ROLLER BEARING: A bearing made up of hardened inner and outer races between which hardened steel rollers move.

ROTOR: 1. The disc-shaped part of a disc brake assembly, upon which the brake pads bear; also called, brake disc. 2. The device mounted atop the distributor shaft, which passes current to the distributor cap tower contacts.

SECONDARY CIRCUIT: The high voltage side of the ignition system, usually above 20,000 volts. The secondary includes the ignition coil, coil wire, distributor cap and rotor, spark plug wires and spark plugs.

SENDING UNIT: A mechanical, electrical, hydraulic or electromagnetic device which transmits information to a gauge.

SENSOR: Any device designed to measure engine operating conditions or ambient pressures and temperatures. Usually electronic in nature and designed to send a voltage signal to an on-board computer, some sensors may operate as a simple on/off switch or they may provide a variable voltage signal (like a potentiometer) as conditions or measured parameters change.

SHIM: Spacers of precise, predetermined thickness used between parts to establish a proper working relationship.

SLAVE CYLINDER: In automotive use, a device in the hydraulic clutch system which is activated by hydraulic force, disengaging the clutch.

SOLENOID: A coil used to produce a magnetic field, the effect of which is to produce work.

SPARK PLUG: A device screwed into the combustion chamber of a spark ignition engine. The basic construction is a conductive core inside of a ceramic insulator, mounted in an outer conductive base. An electrical charge from the spark plug wire travels along the conductive core and jumps a preset air gap to a grounding point or points at the end of the conductive base. The resultant spark ignites the fuel/air mixture in the combustion chamber.

SPLINES: Ridges machined or cast onto the outer diameter of a shaft or inner diameter of a bore to enable parts to mate without rotation.

TACHOMETER: A device used to measure the rotary speed of an engine, shaft, gear, etc., usually in rotations per minute.

THERMOSTAT: A valve, located in the cooling system of an engine, which is closed when cold and opens gradually in response to engine heating, controlling the temperature of the coolant and rate of coolant flow.

TOP DEAD CENTER (TDC): The point at which the piston reaches the top of its travel on the compression stroke.

TORQUE: The twisting force applied to an object.

TORQUE CONVERTER: A turbine used to transmit power from a driving member to a driven member via hydraulic action, providing changes in drive ratio and torque. In automotive use, it links the driveplate at the rear of the engine to the automatic transmission.

TRANSDUCER: A device used to change a force into an electrical signal.

TRANSISTOR: A semi-conductor component which can be actuated by a small voltage to perform an electrical switching function.

TUNE-UP: A regular maintenance function, usually associated with the replacement and adjustment of parts and components in the electrical and fuel systems of a vehicle for the purpose of attaining optimum performance.

TURBOCHARGER: An exhaust driven pump which compresses intake air and forces it into the combustion chambers at higher than atmospheric pressures. The increased air pressure allows more fuel to be burned and results in increased horsepower being produced.

VACUUM ADVANCE: A device which advances the ignition timing in response to increased engine vacuum.

VACUUM GAUGE: An instrument used to measure the presence of vacuum in a chamber.

VALVE: A device which control the pressure, direction of flow or rate of flow of a liquid or gas.

VALVE CLEARANCE: The measured gap between the end of the valve stem and the rocker arm, cam lobe or follower that activates the valve.

VISCOSITY: The rating of a liquid's internal resistance to flow.

VOLTMETER: An instrument used for measuring electrical force in units called volts. Voltmeters are always connected parallel with the circuit being tested.

WHEEL CYLINDER: Found in the automotive drum brake assembly, it is a device, actuated by hydraulic pressure, which, through internal pistons, pushes the brake shoes outward against the drums.

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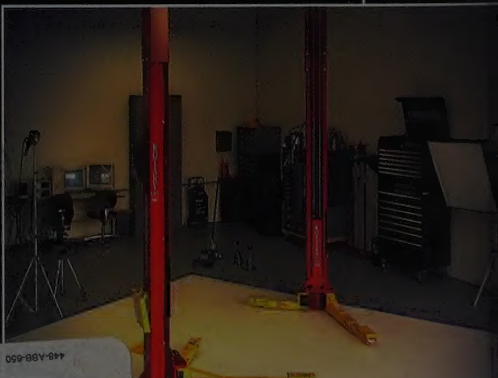

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